JUNE - 20¢

POPULAR SCIENCE

What is the Truth About Our Aircraft Engines?

PAGE 108

GERMAN U-BOAT SECRETS NOW REVEALED

SEE PAGE 57

"Nice goin', baby!"

First in the automotive industry to fly the Navy "E" with three stars, Fisher has also been awarded the Army-Navy "E" for its ahead-of-schedule tank production.

SO it goes, on a dozen fronts — American industry backing up American men with firepower, with a rising flood of war tools and transport, with a heightening volume of all kinds of ordnance.

The Fisher contribution to this effort, in terms of volume, is huge. But volume alone fails to tell the whole story of the Fisher effort. For the long-acquired skills of the Fisher craftsmen are today playing a part of national importance. They have a vital and specific value of their own.

Our country's leaders realize that it takes precision men to do a job precisely — that extreme standards of mathematical exactness must be met in order to surpass the technical excellence of our enemy's war machines. And Fisher, as a precision center, has been honored with a number of very difficult assignments.

Our fighting men are doing the big job. But the vicious snick of our well-turned breech-blocks, the roar of our tanks, the bark of our anti-aircraft guns are music to their ears.

armament
BORN BY *Fisher*

DIVISION OF GENERAL MOTORS

"In 1940 they sold thousands of Silvertowns made with more than half their rubber synthetic," said the Grand Union maintenance man to the WAAC. In fact, he's pointing to one of those tires, bought by his company to help get America's synthetic rubber program started. Grand Union reports wonderful results from these tires—in some cases they outwore natural rubber tires on the *same* vehicle. Two of them ran *7,000 miles* more! Thus synthetic rubber passed its first great test.

The Army rides on synthetic rubber. Today, B. F. Goodrich is making tires for combat vehicles with *proven* synthetic. Already we are overcoming Germany's head start in synthetic rubber. But there still isn't enough for you. The Army and Navy need all the rubber they can get.

Delivery guaranteed in 1947. We can't say when your new car will be ready. But we can say that its tires will probably be made wholly, or partly, from synthetic rubber. So look for the best from B. F. Goodrich, the company that pioneered American synthetic rubber.

A few of the companies that bought Ameripol tires in 1940 and 1941

Aetna Life Insurance Co. . . . American Airlines, Inc. . . . American Can Co. . . . Baltimore & Ohio Railroad . . . J. I. Case Co. . . . General Outdoor Advertising Co. . . . General Baking Co. . . . Gulf Oil Corporation . . . Geo. A. Hormel & Co. . . . Ingersoll-Rand Co. . . . Kellogg Company . . . New York Central System . . . New York Telephone Co. . . . Pet Milk Sales Corp. . . . Railway Express Agency . . . Socony-Vacuum Oil Co. . . . Standard Brands, Inc. . . . Swift & Company . . . The Texas Co. . . . U. S. Gypsum Co. . . . Western Union Telegraph Co. . . . and many other important companies in communities from coast to coast.

In war or peace

B.F.Goodrich

FIRST IN RUBBER

YEAR AFTER YEAR— **THE STORY UNFOLDS!**

"My Argus Works Like a Charm with Children"

says

H. B. SUMMERS

New Albany, Indiana

Like most photographers, Mr. Summers likes to take pictures of children, and the young lady above is his favorite model.

At 16 months, she is already a well-photographed miss, with a personal pictorial record that unfolds the story of her growth, year after year.

These are the pictures prized most by parents. They turn back the pages of the passing years to a series of priceless moments that are kept forever in Argus candid snapshots.

Your dealer may not have all Argus models in stock, but you'll find those he has are top-notch values.

"STROLL IN THE GARDEN"

one of Mr. Summers' splendid pictures that proves how attractive record pictures can be.

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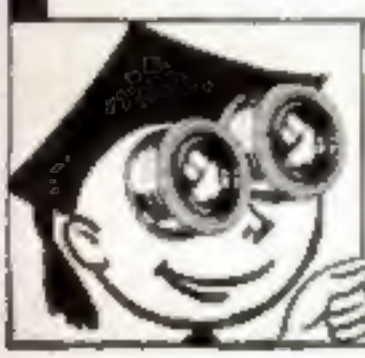

Learn more about composition—lenses—film—and helpful hints for using any camera. Send 25c today for the 56-page book "Good Pictures"

★

argus

ann arbor michigan

Fine American Made Cameras

Popular Science Monthly for June, 1943, Volume 142, Number 6. Published monthly at 353 Fourth Avenue, New York, N. Y., by Popular Science Publishing Co., Inc. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Dayton, Ohio. Yearly subscriptions to the United States, $2.00.

POPULAR SCIENCE

FOUNDED 1872 MONTHLY VOL. 142 NO. 6

Mechanics & Handicraft

A TECHNICAL JOURNAL OF SCIENCE AND INDUSTRY

CONTENTS *for* JUNE, 1943

Cover: Kodachrome by Richie for Wright Aeronautical Corporation

News

Automobiles

Home and Workshop

(Contents continued on page 6)

CAN YOU NAME THIS MEDAL? The bit of bronze and silk shown above is one of the most coveted decorations in the world. Do you know what it is and who is entitled to wear it? The July issue of Popular Science Monthly will contain a special supplement showing in full color the awards and decorations of the armed forces of the United States, including new medals never before published. You will want to preserve this catalog of the honors being won by our heroes today.

Published monthly at 353 Fourth Avenue, New York, N. Y., by Popular Science Publishing Co., Inc. Godfrey Hammond, President and Treasurer; R. C. Wilson, Raymond J. Brown, Vice-Presidents; F. W. Briggs, Secretary. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Dayton, Ohio. Entered as second-class matter at the Post Office Department, Canada. Printed in U.S.A.

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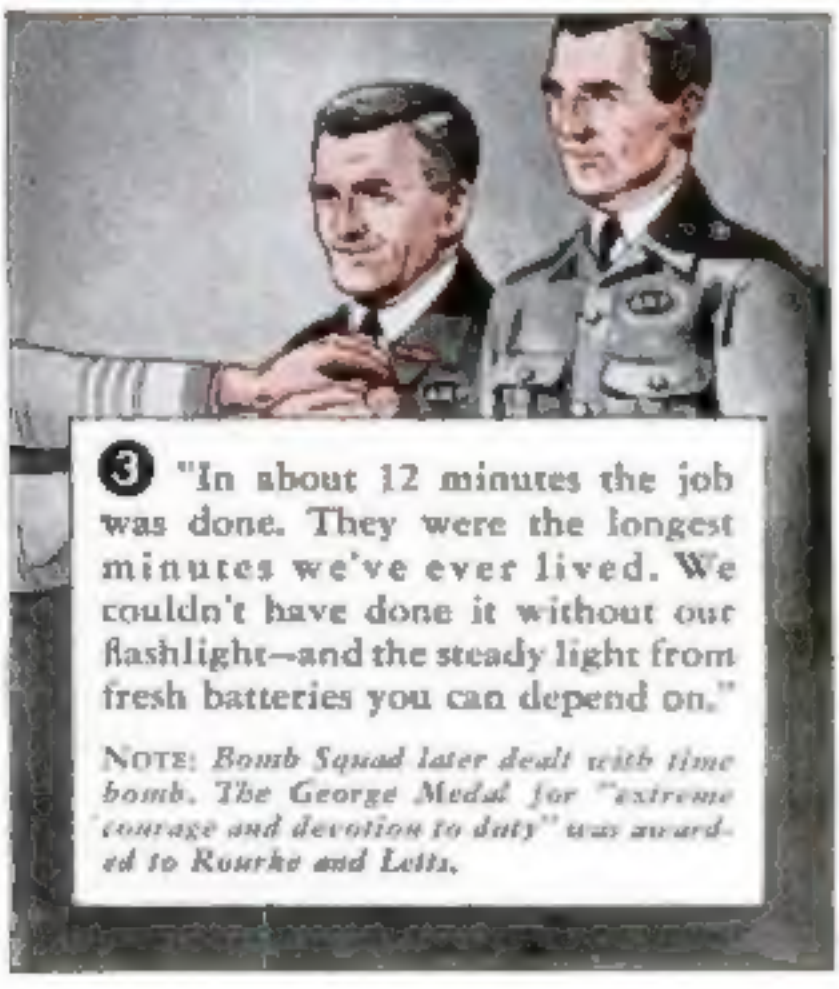
INCHES FROM DEATH, THEY WORKED LIKE FIENDS!

A true story of the blitz in England as told to a War Correspondent by Arthur Letts and Frederick Rourke, gas repair men for the Thames Estuary District, Greater London.

❶ "The night sky was filled with enemy planes, and the earth shook with explosions. At the height of the raid we learned a bomb had smashed a gas main near the works. Rourke and I volunteered for the fixing job . . .

❷ "We found it," continued Rourke. "A big delayed action bomb sitting on a severed pipe in the middle of a three-foot crater. We set to work. Letts held the flashlight, taking care to shield it so the Nazis couldn't see it, while I blocked the broken pipe with clay.



❸ "In about 12 minutes the job was done. They were the longest minutes we've ever lived. We couldn't have done it without our flashlight—and the steady light from fresh batteries you can depend on."

NOTE: *Bomb Squad later dealt with time bomb. The George Medal for "extreme courage and devotion to duty" was awarded to Rourke and Letts.*

OCD approved flashlight regulations stipulate careful shielding of the light from a flashlight during a blackout, as Arthur Letts did. Likewise wartime economy demands strict conservation of both flashlights and batteries.

Use your flashlight sparingly—save batteries! Don't buy a new flashlight unless the old one is beyond repair! Don't hoard flashlight batteries! Don't put in a more powerful bulb than your flashlight calls for—it simply wastes power!

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Unit of Union Carbide and Carbon Corporation

UCC

The word "Eveready" is a registered trademark of National Carbon Company, Inc.

FRESH BATTERIES LAST LONGER...
Look for the **DATE-LINE**

Contents [CONTINUED]

Automobiles

Aviation

Facts and Ideas

Inventions

(Continued on page 8)

Peter Putter

[TRADEMARK]

GOES TO WAR —AT HOME!

Says Peter Putter: "Keeping up the Home Front means upkeep. And when it comes to this kind of Home Defense you can be not only the General but the whole bloomin' Army!"

Right! This is a War against Waste. Every man in America today is his own House Warden. So is every woman. Making things last longer; saving and salvaging; painting and puttering; repairing, revamping, refinishing. That's the spirit of America-at-war! Practical, patriotic and thrifty to boot.

And here are five seasoned soldiers of service . . . Double X, Savabrush, Schalk's Crack Filler, Waxoff, Schalk's Wood Putty . . . on the alert to give you a big, helping hand. Let them show you how to make things do for the duration . . . and then some. Remember, they who SAVE also SERVE.

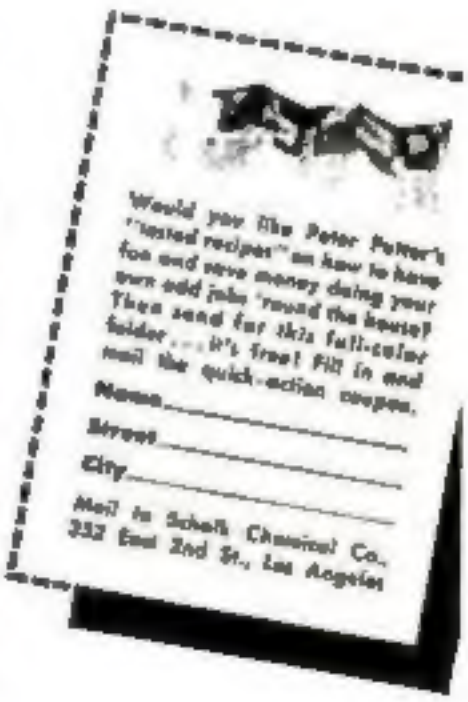
DOUBLE X "Floors run down at the heels . . . scuffed, scarred, traffic-tired! Bring back their youth and beauty with Double X," says Peter Putter. Here is the white magic that makes varnish vanish and makes old floors new. All you need: a pound can of Double X (75¢ at paint, hardware stores); a pail of boiling water; a brush or mop; steel wool. Double X is double-action: removes and bleaches in one operation!

SAVABRUSH "Any caked-up paint brushes huddled away in attic or garage? Bring them out and bring them back to life with Savabrush," says Peter Putter. We don't have to tell you the war has put a premium on good brushes. Save what you have! Here is a presto-powder that (when dissolved) loosens paint, varnish, shellac, enamel . . . cleans bristles right down to the heel. A 10¢ carton saves several brushes.

SCHALK'S CRACK FILLER "Why put up with unsightly cracks, holes, nicks in wood, wallboard, plaster, tile, when Schalk's Crack Filler is on tap?" asks Peter Putter. You can do all sorts of time-saving, dollar-saving tricks with this 10¢ magic repair-kit. All you add to this plastic-powder is water. Hardens fast and stays hard. Won't shrink, crack, crumble. You can cut it, saw it, model it, paint or stain it any color.

WAXOFF "Don't revarnish or rewax before you Waxoff," cautions Peter Putter. "Then you're sure the varnish will dry." The only product of its kind, Waxoff is the modern speed-way to remove wax, floor oil, polish, ground-in dirt, before revarnishing or rewaxing. What's more, Waxoff can't explode; can't hurt your hands. A 10¢ package is cheap insurance against "tacky" varnish and lack-lustre wax jobs.

SCHALK'S WOOD PUTTY "When things go to pot, go to Wood Putty," advises Peter Putter. "My favorite is Schalk's because it contains real wood and is so easy to work." The ideal emergency remedy for 101 household ills. It fixes furniture; sets loose joints, casters, etc. Can be sawed, sandpapered, painted, varnished. Costs a dime (at paint, hardware stores) yet saves many a dollar in household repairs.



Contents [CONTINUED]

Craftwork

Electrical

(Contents continued on page 10)

PARTNERS IN THE BUSINESS OF VICTORY!

WHEN it comes to winning a war, one *trained man* is worth a dozen untrained men!

That's true of America's armed forces—which need chemists, mechanics, machinists, electricians, radio experts, accountants and a dozen other classifications of trained men. And trained men in America's armed forces get better pay and higher ranking!

It's true of America's victory-vital industry. Today, business and industry are crying for skilled, trained manpower! Never was opportunity greater for the alert, ambitious man who has mastered his line of work through study and practice!

Yes, the *trained man in uniform* and the *trained man in industry* are "partners in the business of victory." Whether you're serving Uncle Sam in barracks or factory, farm or office, TRAINING can make you a more valuable citizen and a real asset to your country!

Before you turn this page—tear off this coupon, mark it and mail it—just as thousands of successful men have done!

INTERNATIONAL CORRESPONDENCE SCHOOLS

HELPING TO TRAIN AMERICANS FOR VICTORY

SPECIAL TUITION RATES FOR MEMBERS OF THE ARMED FORCES ★

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- ☐ Public Works Engineering
- ☐ Pulp and Paper Making
- ☐ Radio, General
- ☐ Radio Operating
- ☐ Radio Servicing
- ☐ [redacted]
- ☐ R. R. Signalman ☐ Refrigeration
- ☐ Sanitary Engineering
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- ☐ Ship Drafting
- ☐ Shipfitting ☐ Shop Practice
- ☐ Steam Electric ☐ Steam Engines
- ☐ Steam Fitting
- ☐ Structural Drafting
- ☐ Structural Engineering
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- ☐ Foremanship ☐ French
- ☐ Good English
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- ☐ Secretarial ☐ Spanish
- ☐ Showcard and Sign Lettering
- ☐ Traffic Management

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- ☐ Foods and Cookery
- ☐ [illegible] Dressmaking
- ☐ Professional Dressmaking and Designing
- ☐ Tea Room and Cafeteria Management, Catering

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City..... State..... Present Position.....

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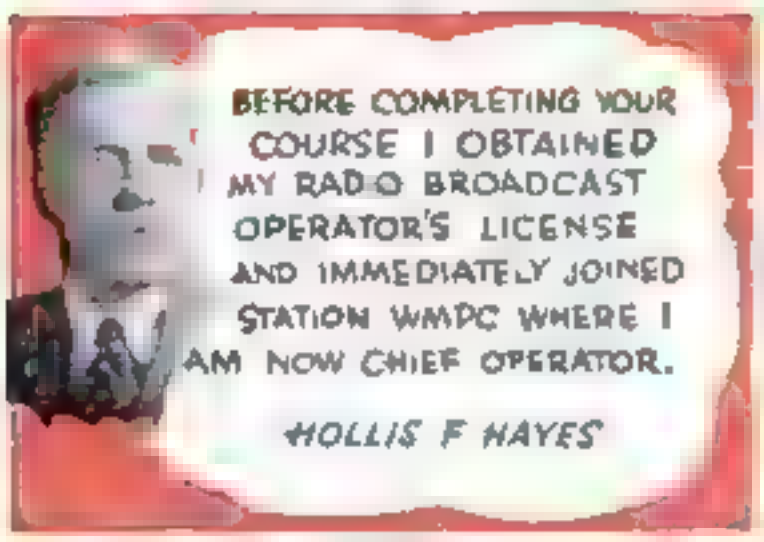
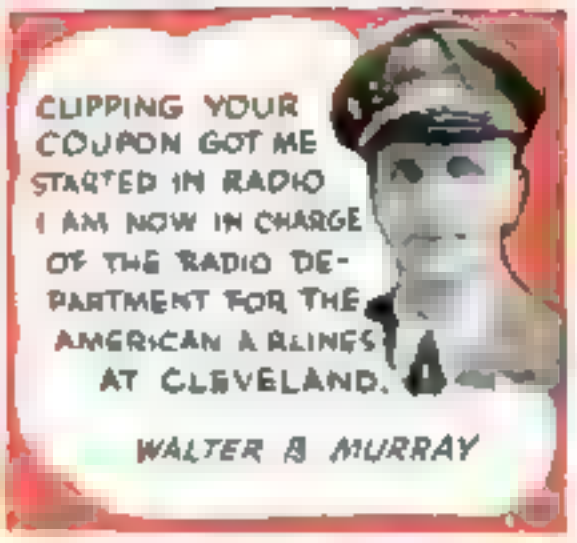
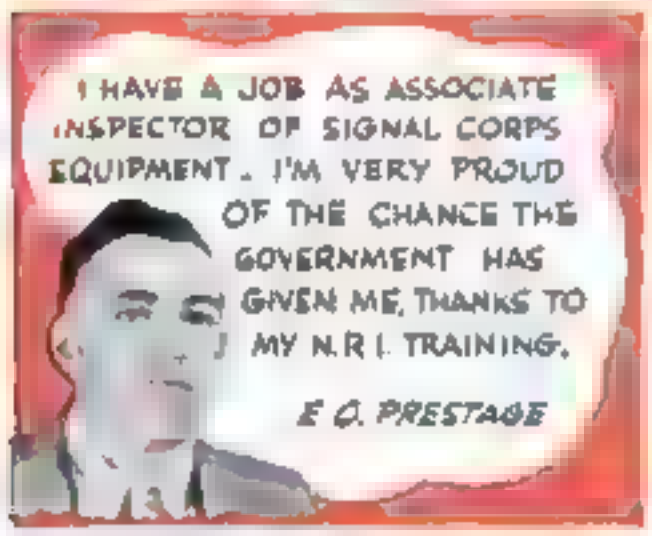
British residents send coupon to I. C. S. 71 Kingsway, London, W. C. 2, England

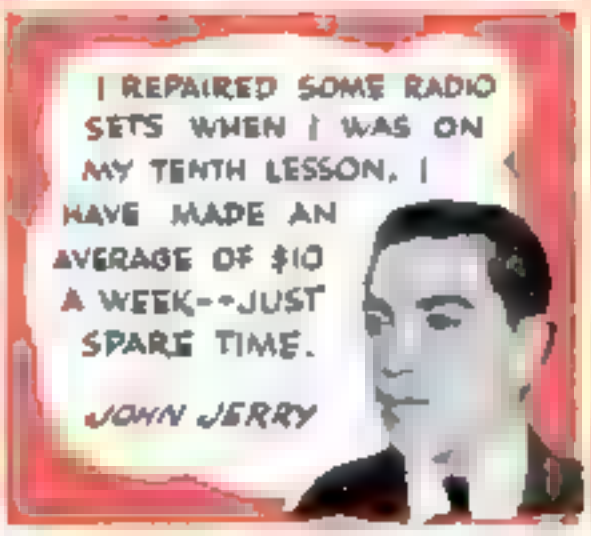
Contents [CONTINUED]

Do You Want Success Like This in RADIO









Here's the Plan That Has Worked For Hundreds

Here's your chance to get a good job in a busy wartime field with a bright peacetime future! There is a real shortage today of trained Radio Technicians and Operators. So mail the Coupon for my FREE 64-page illustrated book WIN RICH REWARDS IN RADIO. It describes many fascinating types of Radio jobs; tells how you can train for them at home in spare time.

More Radio Technicians and Operators Now Make $50 a Week than Ever Before

There is a big shortage of capable Radio Technicians and Operators because so many have joined the Army and Navy. Fixing Radios pays better now than for years. With new Radios out of production, fixing old sets which were formerly traded in, adds greatly to the normal number of servicing jobs.

Broadcasting Stations, Aviation and Police Radio, Ship Radio and other communications branches are scrambling for Operators and Technicians to replace men who are leaving. You may never see a time again when it will be so easy to get started in this fascinating field. The Government too needs hundreds of competent civilian and enlisted Radio men and women. Radio factories, with huge war orders to fill, have been advertising for trained personnel. And think of the NEW jobs Television, Frequency Modulation, and Electronics will open after the war! This is the sort of opportunity you shouldn't pass up.

Extra Pay in Army, Navy, Too

Men likely to go into military service, soldiers, sailors, marines, should mail the coupon now! Learning Radio helps men get extra rank, extra prestige, more interesting duties, SOMETIMES EXTRA PAY. Also prepares for good Radio jobs after service ends. Over 1,700 service men now enrolled.

Many Beginners Soon Make $5, $10 a Week Extra in Spare Time

There's probably an opportunity right in your neighborhood to make money in spare time fixing Radios. I'll give you the training that has started hundreds of N.R.I. students making $5, $10 a week extra within a few months after enrolling. The N.R.I. Course isn't something just prepared to take advantage of the present market for technical books and courses. It has been tried, tested, developed, perfected during the 28 years we have been teaching Radio.

Find Out What N.R.I. Can Do for You

MAIL THE COUPON NOW for my FREE 64-page book. It tells how N.R.I. trains you at home, shows you letters and photographs of men I trained, describes the many fascinating jobs Radio offers. No obligation—no salesman will call. Just MAIL THE COUPON AT ONCE in an envelope or paste on a penny postal.—J. E. SMITH, President, Dept. 3FP2, National Radio Institute, Washington, D. C.

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I Trained These Men at Home I Will Train You Too

THIS FREE BOOK HAS SHOWN HUNDREDS HOW TO MAKE GOOD MONEY

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Mail me FREE without obligation your 64-page book "Win Rich Rewards in Radio." (No salesman will call. Write plainly.)

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Coming Next Month

AMERICAN BOMBERS drew the day shift in the 'round-the-clock raiding program that is softening up Hitler's European fortress. Have they made good? William S. Friedman tells how high-altitude, precision bombing fits into the air strategy of the United Nations, and why that kind of work is right up the alley of our Fortresses and Liberators.

SELF-PROPELLED GUNS have been making history on the battlefield. Contrary to common belief, the mechanized gun mount is not a "surprise" weapon sprung on an unsuspecting world at the beginning of the present war. American ordnance engineers pioneered in this field 25 years ago and their continued experiments have enabled us to beat the Nazis at the game. Read the story of our development of this powerful weapon and our present leadership.

DEHYDRATING FOODS at home is the next step after you have planted and grown your Victory garden. And because they are tasty, nutritious, and patriotic, they are well worth the slight trouble they require to prepare. Here is an article that tells you how to build a drier, prepare the fruits and vegetables for dehydration, and pack them against the time when you may suddenly crave them—and find that there just aren't any in the market.

AMERICANS ARE SMOKING more today than they ever did before. What is the secret of this magic weed, tobacco, which gives comfort to millions—and, incidentally, forms the basis of a $2,000,000,000-a-year industry? You'll learn a lot of things you didn't know about tobacco—and probably find that some of the things you thought you knew aren't quite true.

AMMONIA is one of the indispensables of war. Besides being a basic ingredient of explosives, it has an important place in the hardening of metals and in the manufacture of plastics and fertilizers. Fortunately, we are no longer dependent on a precarious supply of imported natural nitrates for this essential of victory. Albert Q. Maisel tells how industrial chemists now wrest ammonia from air and water.

SILHOUETTES and shadows are sure fire devices for getting mood and dramatic effect into your photography. But they call for a knowing hand. James Howe Wong, A.S.C., lets you in on some of the professional secrets of composition, exposure, and choice of subject that have made him one of Hollywood's ace cameramen in this field of "shadow and substance."

She SAID: I'm sorry I can't go with you tonight..

But She really THOUGHT: I'm ashamed to be seen out with such a SKINNY WEAKLING!

Charles Atlas

An actual untouched photo of Charles Atlas, holder of the title "The World's Most Perfectly Developed Man."

DO YOU ever get the brush off? Do girls ever tell YOU they have a headache—and then the headache turns out to be another date? Well, girls just seem to prefer going out with a husky, muscular HE-MAN! And if you want to start building a HE-MAN's body for YOURSELF, just listen

Give Me Just 15 Minutes a Day—and I'll PROVE I Can Make YOU a NEW MAN!

I can show you dozens of pictures of skinny, scrawny weaklings that I've helped to become brawny, big-muscled supermen! I'll show you a picture of myself at 17—a spider-legged, sparrow-chested specimen—and then compare it with this picture of me today! What I did for those other men—and for myself—let me PROVE I can do for YOU, too!

I can begin showing you RESULTS the very first week. REAL results, MUSCLE-results. You'll soon have INCHES of powerful muscle along your arms. Broad, powerful shoulders. Husky chest. Strong, muscle-ridged back and stomach—legs lithe and springy. I'll give you a firm, vise-like grip. I'll fill your whole system so full of new vigor and vitality that you won't even KNOW YOURSELF!

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In just 15 minutes a day, right in your own room, my method of *"Dynamic Tension"* will start molding your body into rugged health and strength. *"Dynamic Tension"* is nature's own body-building system. No apparatus, or artificial muscle-makers. Before long you'll be using *"Dynamic Tension"* unconsciously during the day—walking, bending over, while sitting down, resting—to build muscle and vitality! You'll be using the muscle-power you have NOW to build the muscle-power you WANT to have!

—Charles Atlas

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Send coupon below for my big, 48-page illustrated book, "Everlasting Health and Strength." Over 2 million men have read this book. I tell you what *"Dynamic Tension"* can do. Then in nearly 100 pictures I SHOW you living PROOF of what it has done for others! Send coupon today! Address me personally: *CHARLES ATLAS, Dept. 16, 115 East 23rd Street, New York, N. Y.*

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I want the proof that your system of *"Dynamic Tension"* will help make a New Man of me—give me a healthy, husky body and big muscular development. Send me your free book, "Everlasting Health and Strength."

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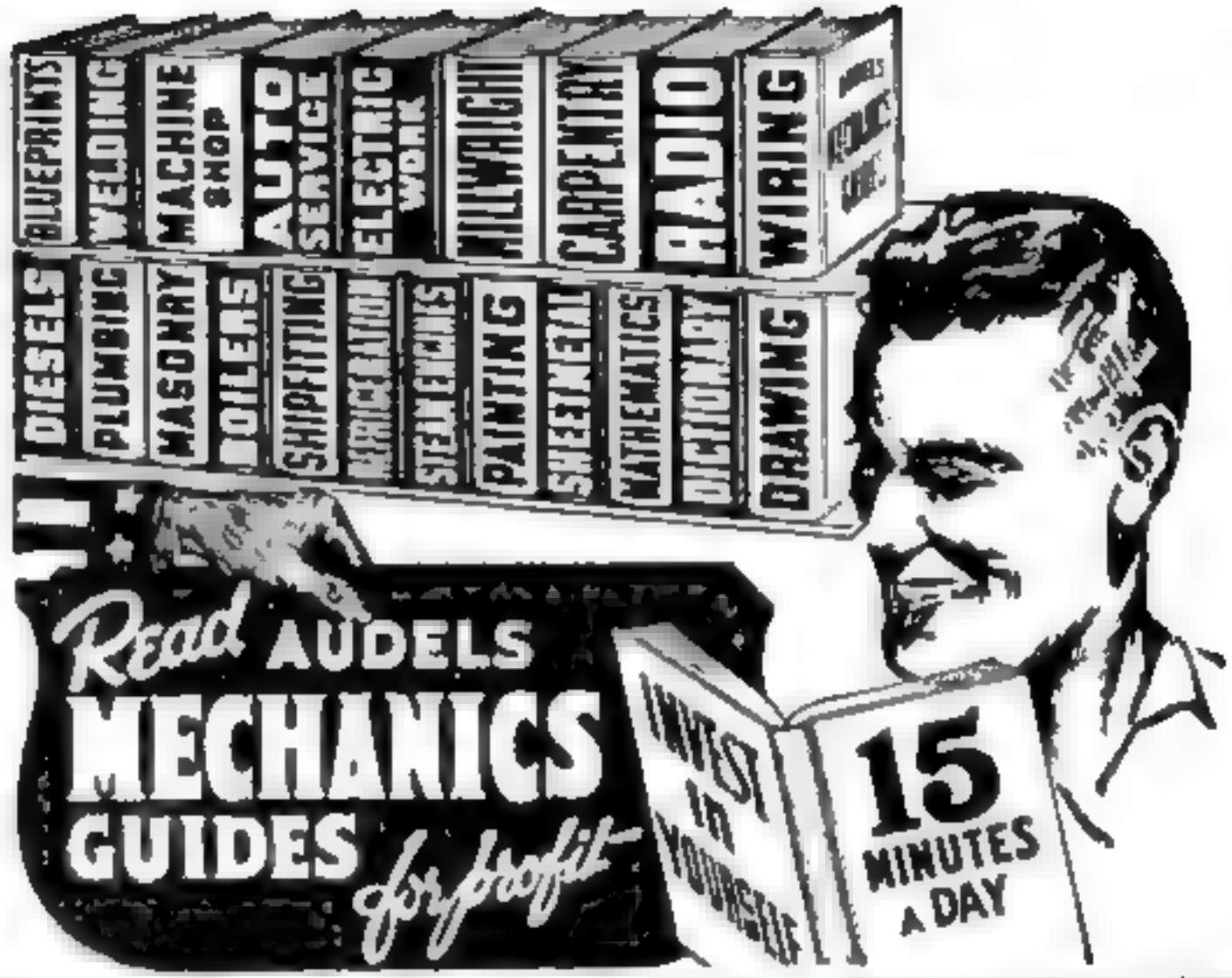
A key to the practical understanding of radio including Frequency Modulation, Television, etc., Aircraft and Marine Radio. For radio engineers, servicemen amateurs 772 pages 400 Illustrations and Diagrams Photos. Review Questions and Answers Ready Reference Index Authentic, clear, concise.



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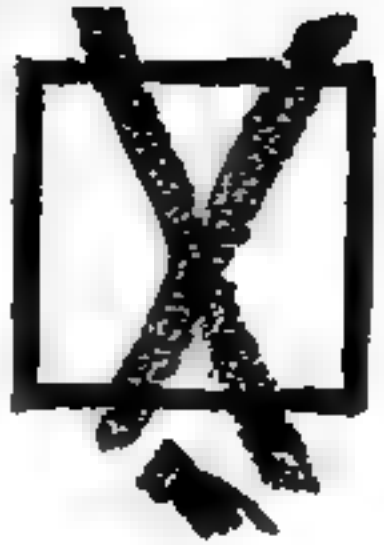

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Readers Say:

Where Was Chemistry on the Night of February 20?

In your February, 1940, issue you told how synthetic rubber could be made by condensing linseed oil and sulphur in the proper proportions. On the night of February 20, 1943, I gathered some chemicals together, called in some friends and bravely we set forth, little knowing what lay ahead. Mixing the ingredients in what we thought were the proper proportions, we placed them on a hot plate. Suddenly, as if by magic, the room was filled with smoking linseed, sizzling sulphur, and flames of fire that shot several feet into the air. Gasping and choking, we tried to put out the fire by pouring a bucket of water over the hot plate. After the fourth attempt we brought the conflagration under control. The net result: one hot plate covered with a thick coat of linseed oil and sulphur; one rug divinely ruined; and three disheartened scientists. P S Please tell us what we did wrong.—P. V., P. R., and R. B., Edmonton, Alb., Canada.

Could the Idea Always Have Been Bugs?

I am writing in regard to the article, "Factory Roof Floats on Air," that appears on page 54 of your April issue. I'm afraid the whole idea is just too silly. To begin with, the roof, to float on air, must of necessity be extremely light. That's just where the trouble would begin. Strong winds, you see, have not as yet become extinct in this country, and the chances are that should such a factory roof be constructed it wouldn't be long before a playful breeze would come wafting along to carry the roof off to some distant field where it could probably be used more advantageously to keep the hot sun off young caterpillars.—B. K., Demarest, N. J.

Friction—Ay, There's the Rub, Eh, Fiend?

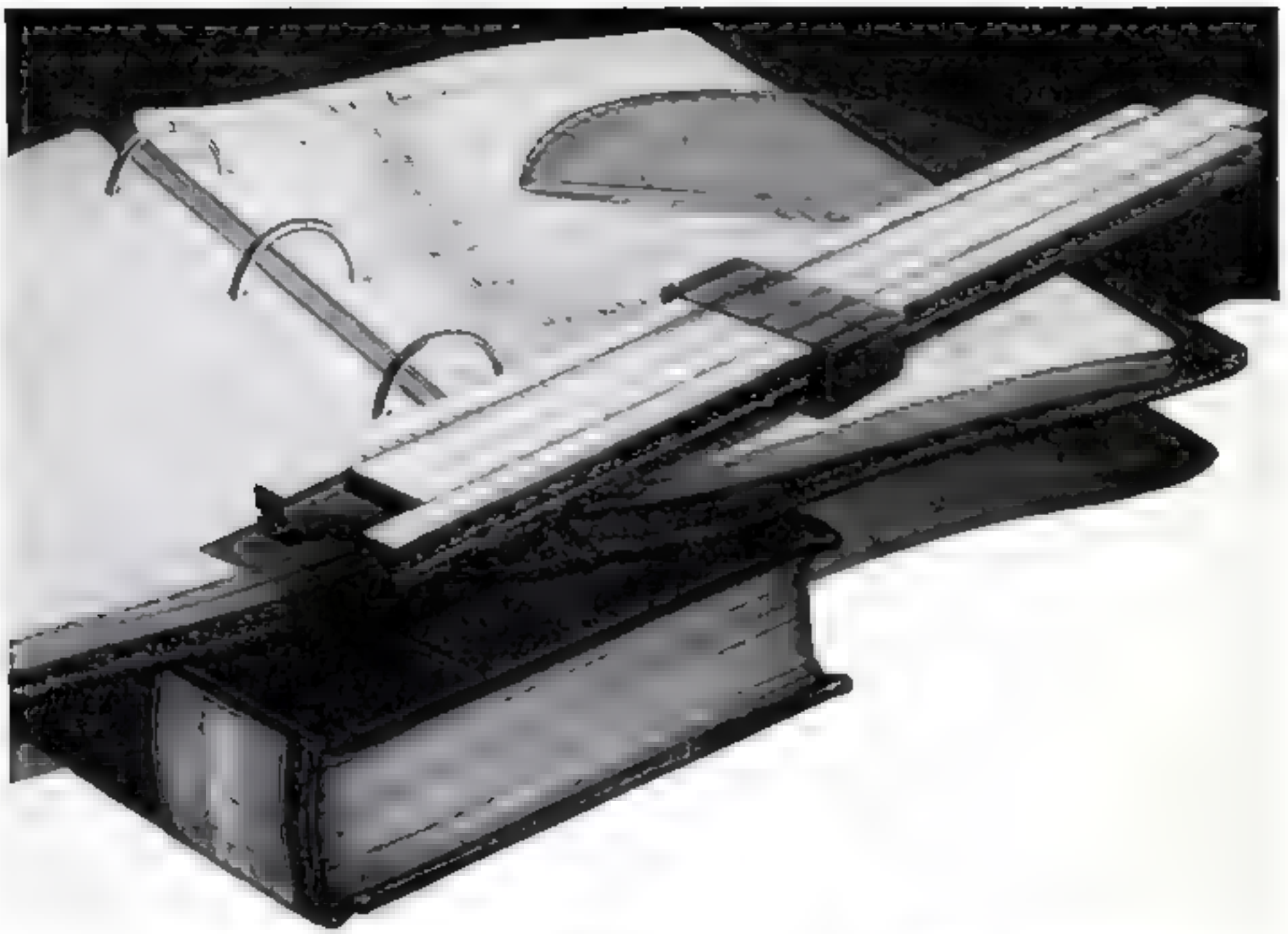
The 14-year old youngster whose item appeared in your April issue, and who believes he has found the secret of perpetual motion might take some advice from a wiser head It is this: greater minds than his have tried to build perpetual motion machines and failed. The reason is that friction can not be eliminated. Friction will slow down anything that depends only on the force produced by its own motion to keep replenishing that motion. Please publish more ideas like this. I take a fiendish delight in tearing them down. P S. I am 15 years old.—A. A., Washington, D. C.

This Wife Is Growing Fond of Her Rival

Though married only three months, I feel as if I were single again whenever the current issue of P.S.M. comes to our house. My husband reads the darn thing from cover to cover and I may as well be talking to thin air until he has finished. However, the next day I get a chance at it, and so peace is maintained in the family. I've begun to enjoy P.S.M. very much indeed —Mrs. C. G.

He'd Like to Take a Look into the Future

In your February, 1943, issue you carried something about Dr. Michel Nostradamus who lived in the 16th century and who made some amazing prophecies and predictions, all of which are now coming true. If I recall correctly, this great prophet foretold the future by peering into the depths of enormous caldrons where he brewed strange concoctions. His work greatly interests me, and if you could only tell me of any books of his that I might secure I would be only too happy to buy them all. I would be willing to pay a good price for them.—H. W. S., Chicago, Ill.



What's a cotangent got to do with ack-ack?

PLENTY. So have sines, cosines, squares and square roots, differential equations, and integral calculus.

For the accurate firing of anti-aircraft batteries depends wholly upon the science of mathematical calculations that must be made fast—faster than a score of the most brilliant mathematicians could do it!

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Readers Say:

The Sarge's Dud Evening Came Up with a Bang

WHILE casting about the mess tonight for something to read I came across the April issue of P.S.M. among those magazines that have been donated to us. I had never read the magazine before and I got a real bang out of it. I hope we get other copies of it because it certainly changed a "dud" evening into an enjoyable one. I read the whole thing through, and then wound up with "Readers Say," which prompted me to write this letter.—Sgt. F. I. H., Queen's York Rangers, C. A., First American Rangers, Niagara-on-the Lake, Ont., Canada.

These Cheesy Titles Are Bait for Readers

AS A BUSY chemist and technical director of a paper company, I don't have as much time to spend on P.S.M. as I would like to. I read your articles on chemistry, of course, from beginning to end and I enjoy them. But I do have a criticism to make on one section of your magazine—and that is "Readers Say." It seems to me you should have better titles. They pique my curiosity so that it gets the better of me and makes me read the whole darn thing. Is that an editor's trick?—H. R. A., Northbrook, Ill.

Wonder Why He Needs a Lie Detector?

I HAVE read your magazine for years and I feel its most attractive quality is its friendly attitude. Incidentally, I believe a couple of years ago you published a diagram for building a "lie detector." I wonder if you could supply me with a copy of the plans as I have occasion to make use of the device.—L. E. J., Lewiston, Me.

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When Singing Telegraph Wires Are Off Key

IN YOUR April issue there appears an inquiry from C. C., of Luther, Okla., as to what causes telephone and telegraph wires to give off musical sounds at various times. Dr. W J. Humphreys, of the U. S. Weather Bureau, explains the phenomenon in his book, "Ways of the Weather," in which he tells just how eddies of wind around a stretched wire set up the singing note. In fact, if C. C. would also like to know just what note the wires are singing, the following formula may be of assistance to him: $N=3.25\frac{V}{D}$. Here N is the number of vibrations per second (which determines the pitch), V is the velocity of the wind in miles per hour, and D is the diameter of the wire in inches.—F. D., Hancock, N. Y.

This Cook Has Got Himself into a Stew

I HAVE just finished reading the article, "Your Cup of Coffee," that appears in the April issue, and in which is given methods for stretching coffee rations with substitutes. Let me say that there would be no coffee shortage if people would only throw away such freak coffee-makers as percolators, dripolators, and all the other nonsensical—ators. These contraptions were invented for only one purpose—to increase consumption. Let me tell you that it is *not* necessary to use a tablespoonful of coffee for each cup. Coffee that strong could float a battleship, and would be fit to drink only by a person with a hangover from a three-day spree. No one has ever improved on the common pot method of making coffee, and no one ever will. Using a "drip" grind, three rounded tablespoonfuls will make seven cups. Just put the coffee in cold water, and then turn off the heat as soon as the water boils. And there you have it. Coffee—not roofing tar.—C. J., Elgin, Ill.

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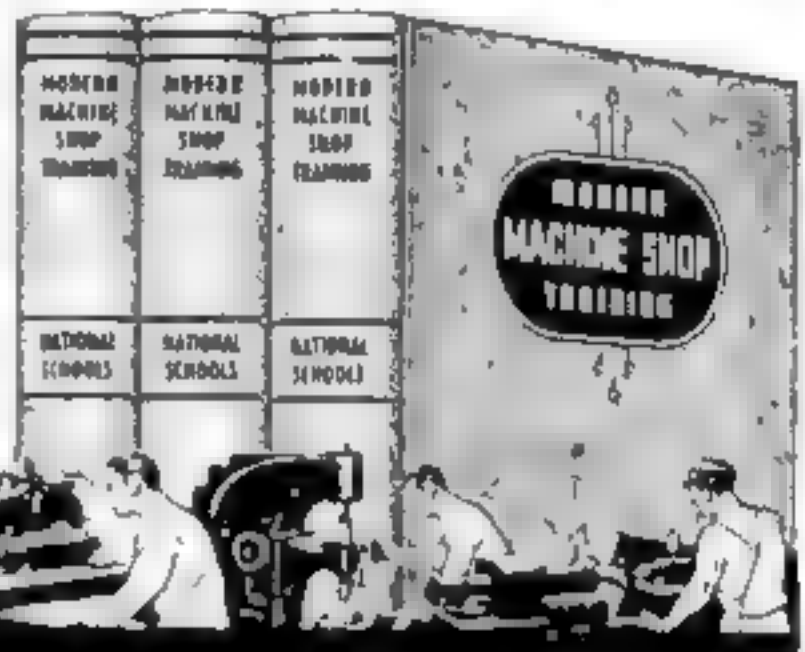

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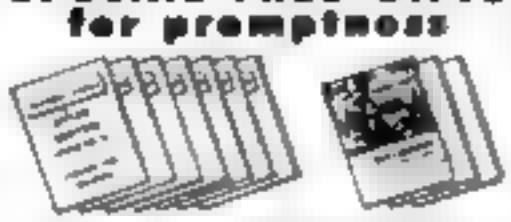

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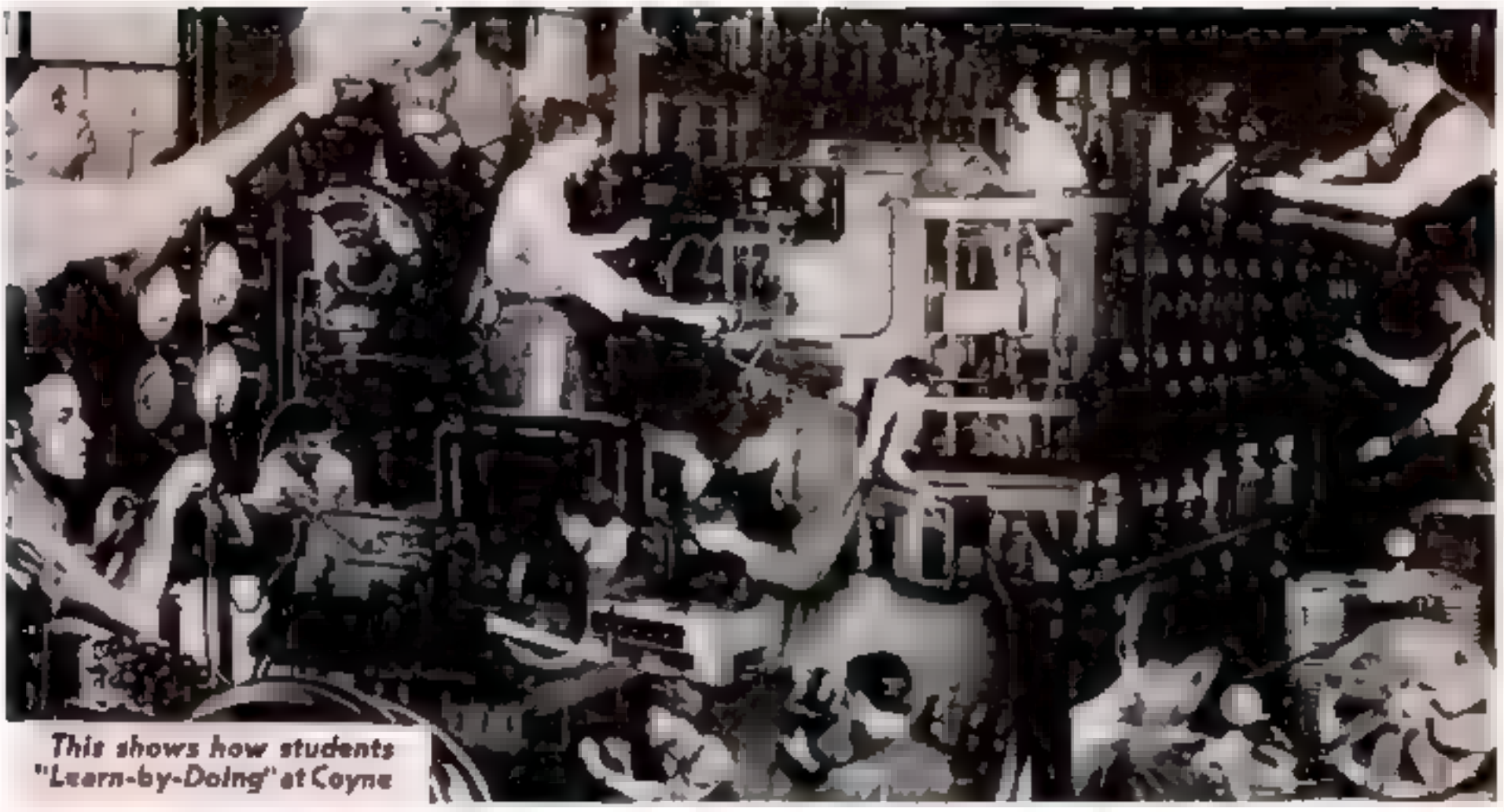

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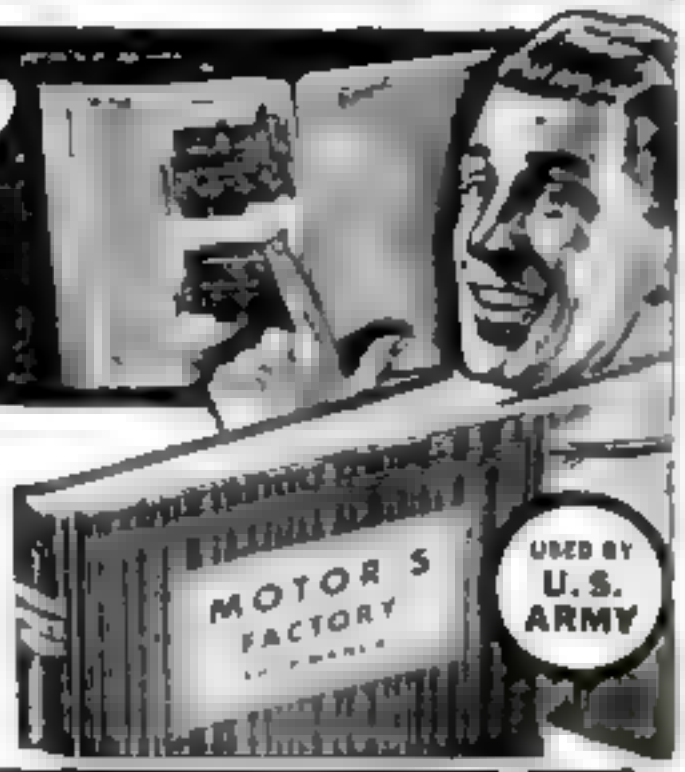

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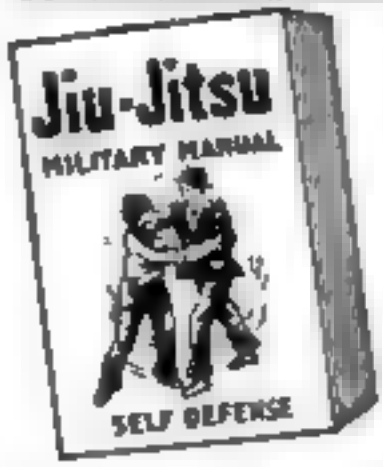

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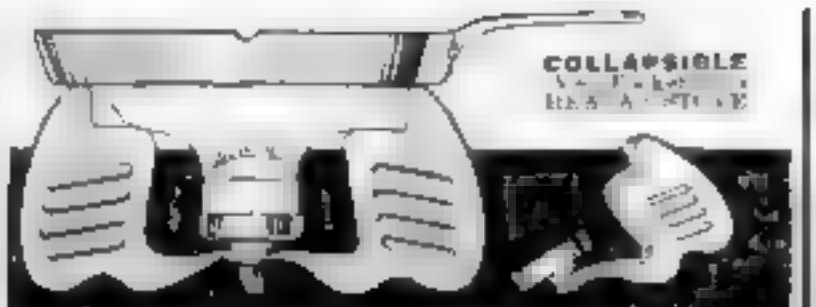

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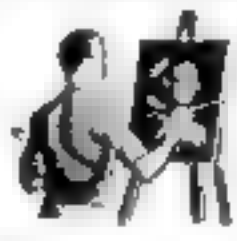

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When Writing Advertisers Please Mention POPULAR SCIENCE

Messengers of Battle

IT TAKES SIGNALING AS MUCH AS GUNS TO MAKE COMBAT TEAMS INVINCIBLE

By JOHN H. WALKER

MODERN war is fought not only to the chatter of machine guns, but also to the chatter of teletype machines. The jingle of a field-telephone bell and the high-pitched, staccato beeping of a radio code set are as significant in their way as the rumble of trucks or the barking cough of a mortar shell.

For communications have become the lifeblood of military operations. An army which had every other item of equipment for war, yet lacked wire and radio communications, would be no better in the fast-moving warfare of 1943 than a blind, stupefied giant, stumbling bravely but hopelessly to defeat and destruction.

The task of maintaining communications for the U. S. Army is primarily the job of the Signal Corps; within that Army the Corps' function is roughly that of the nervous system of a champion athlete. Our Signal Corps, with its equipment and men, provides the means by which information is gathered and transmitted from every part of the Army's vast organism to its guiding brain. Then back along the same channels go orders and instructions. Without this interchange of reflexes and reactions the Army would not be a living mechanism. Communications make it a co-ordinated striking force instead of a disorganized conglomeration of men and machines working blindly in the

This soldier is using a new Signal Corps radio designed primarily for cavalry use. A flexible tube on the chest unit serves as receiver and transmitter. Hand unit is mounted on a standard that fits into the guidon boot of a saddle or on a jeep's bumper

MANY METHODS OF COMMUNICATION ARE USED TO DIRECT

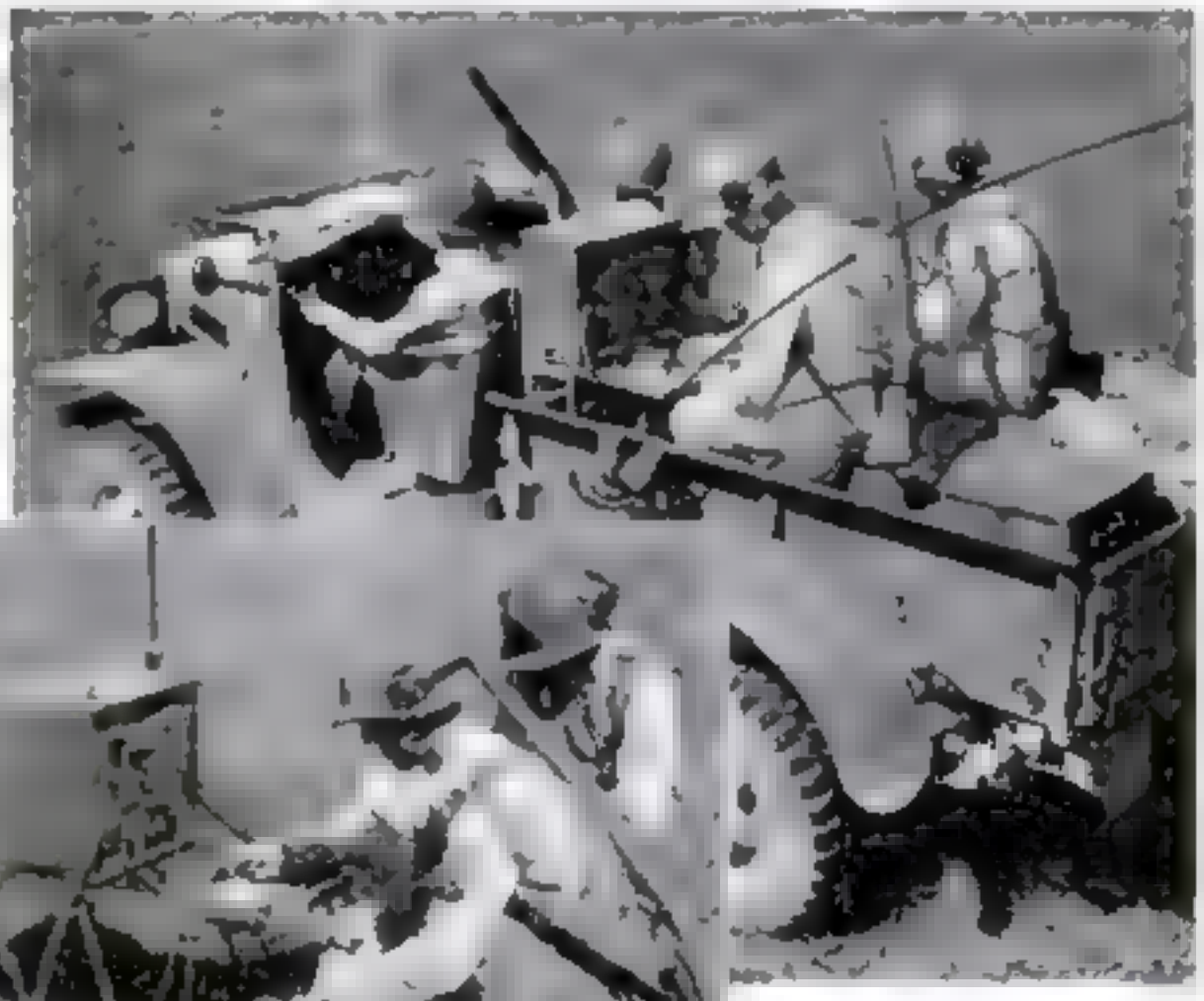
dark. The Signal Corps uses every method of communication, from the basic device of having one man walk over to another and tell him something, right up through to the most precise and complex developments of advanced radio technology—developments which are still held as closely restricted military secrets.

In between these extremes the Army employs messengers in vehicles (anything from a motorcycle or a jeep to an airplane); wire communication (telephone, telegraph, and teletype) to the fullest possible extent; radio transmitters and receivers by the tens of thousands. Older methods are by no means forgotten; signal flags and lights, flares and rockets, cloth panels, all have their uses at times.

RADIO ON TRUCK SENDS AND RECEIVES VOICE AND CODE

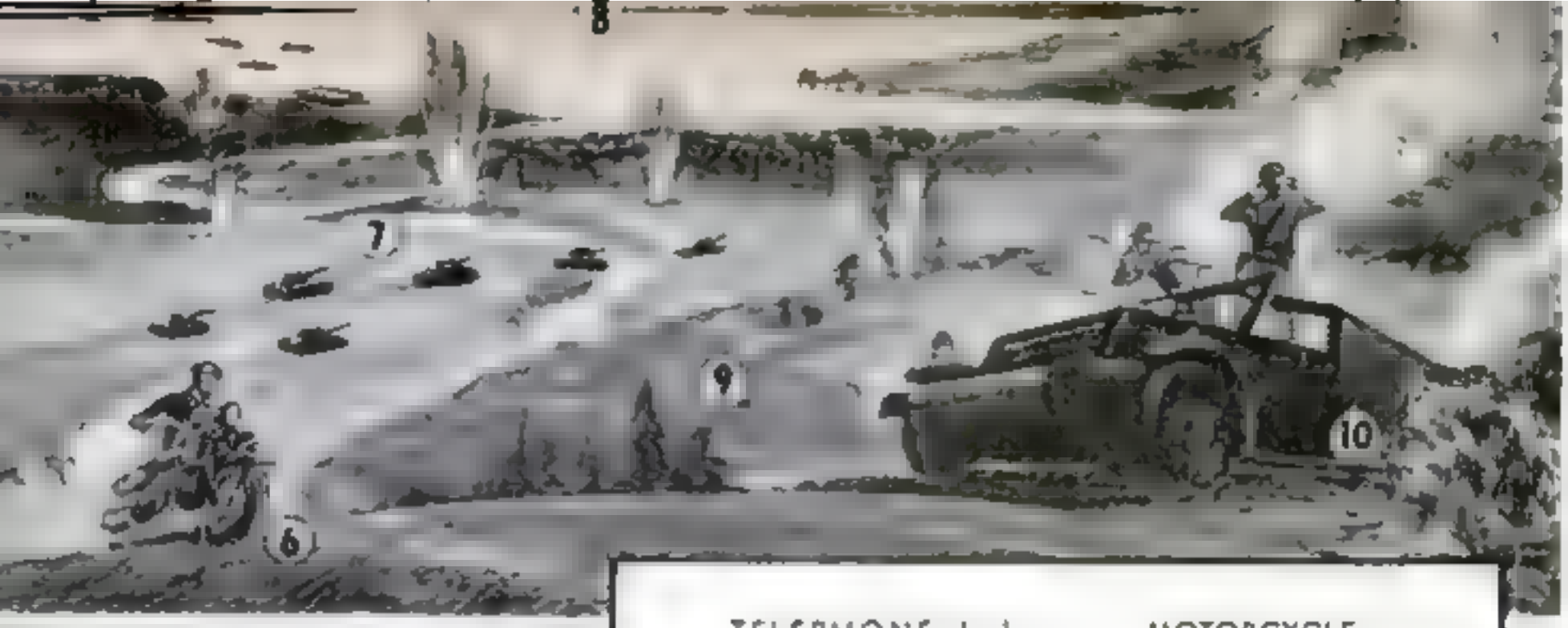
IN THE TRUCK

Normally mounted in a half-ton weapons carrier, this artillery radio sends and receives either voice or code. Its crew consists of a sergeant, driver, key operator, and log operator. Power is taken from the truck's own system



ON THE GROUND

Dismounted the set is operated with power from a hand generator. A telescope aerial is provided for such use



UNITS IN ACTION

1 TELEPHONE links regimental and battalion headquarters with the command of the division

2 TELETYPE provides almost foolproof communication, permanent record at both ends of line

3 PLANE RADIO transmits vital information of enemy movements helps direct artillery fire

4 SHIPS RADIO in operations near coast, aids in observation or co-ordinates landing parties

5 SIGNAL FLAGS get messages through when other methods of communication are not available

6 MOTORCYCLE couriers carry reports or orders. Other vehicles, including the jeep, are used

7 TANKS' RADIO is a direct link between fast-moving fighting units and the unifying brain

8 SIGNAL LIGHTS, rockets, and flares are used on occasion Code blinkers for amphibian work

9 CLOTH PANELS laid on the ground in prearranged patterns, give reports to friendly planes

10 COMMAND CARS are equipped as communications centers for observation, reconnaissance

Naturally enough, however, the most striking Signal Corps developments since 1917-18 have been in the field of radio, and here progress has been exceptionally fast in the last few years. Army experts, working closely with U. S. manufacturers, have designed and perfected a whole series of special military radios, unsurpassed by any such equipment in the world. Among these is the amazing "handie-talkie" portable set, the latest refinement of the walkie-talkie.

There also is a whole series of new frequency-modulation radios of medium range, developed primarily for artillery use. These sets may be used by forward observers to order and direct field-artillery fire. Other types are employed by commanding officers to keep in touch with the batteries in their command net. Voice transmission has obvious advantages of speed and flexibility over code for these uses. FM transmission cuts through static and local interference.

One of these sets designed for artillery observers is mounted on a jeep, drawing power from the car's electrical system through a converter. But the radio often must go up where even the jeep cannot follow, so the set can be unshipped and carried forward by hand, using battery power. One husky man can haul it along, although it is a rugged outfit weighing about 100 pounds. Another, more elaborate artillery radio set, mounted in an officers' command car, can work a number of prearranged frequency channels and is operated by push buttons, much like those of a home radio.

Because of the global scope of U. S. military operations, all this new Signal Corps equipment has to be designed to function equally well in the deserts of North Africa, the bitter climate of Iceland, or the steaming jungles of the South Pacific. For this reason, all experimental models are put through a brutal series of laboratory tests —in steam rooms, refrigerator chambers, blasts of sand or dust, showers of water. After that come field tests, with the equipment mounted in jeeps, trucks, or tanks, pounding up and down over the worst test courses the officers can devise.

The outfits that stand up—or that can be redesigned and rebuilt to stand up—are ready for anything. But even the best equipment is subject to breakage, damage, or failure in the field. The Signal Corps pays special attention to field maintenance, and has even planned and built a mobile repair-shop truck, mounted in a bus body and accompanied by a 1½-ton cargo truck towing a trailer.

Skilled technicians can make any type of repair or adjustment in this shop unit, which normally carries a crew of eight men

and two drivers. To protect the delicate meters used, the workshop truck can be closed up and air-conditioned.

The spectacular development of radio communication in battle should not blind us to the continuing importance of older methods. If there is one thing above all else that a good signal officer worries about, dreams of, and battles to maintain, it is effective wire communication. And the wire-communication system of 1943 is a vastly different proposition from that of 1918.

The special advantages of wire over radio are obvious. As one Signal Corps officer expressed it:

"With radio, you get the sets, issue them, and hope for the best. They're wonderful, of course; we couldn't do without them. But when you've got a good wire circuit in, you're not kidding. It gives you direct, instant, and *private* communication. The enemy normally can't pick it up with intercept equipment or triangulate on the sending source. Atmospheric interference can't blot your messages out. Yes, wire may be hard to maintain, but it's awfully easy to talk over."

Wire-laying methods have been greatly improved. Long experience has shown that wire lines laid directly along a road are too easily broken or damaged. Where the distances are not too great and considerations of speed not too pressing, the wire crew tries to get away from roads altogether and lay its lines across country. Any truck can serve as a wire carrier, and when the going gets too tough even for the hardy jeep, the crew goes it on foot.

Where possible, double circuits are provided between important points. To achieve this, a wire crew may work its way over rugged country, then back over a somewhat different route, laying the second line, while Army business already is flowing over the first.

Probably the Army's one favorite method of communication is neither the radio nor telephone, but the teletypewriter, which gives direct private connection, provides an identical permanent record of every message at both ends, and thus comes as close as any human device can to eliminating the possibilities of error.

A good field commander, however, isn't likely to waste much time arguing one method against another. He is a glutton for communications, and wants all he can get of every type. His dream of perfect happiness in this respect is to have all lines of communication, from radio to carrier pigeons, laid out in parallel and functioning with faultless efficiency. It's never been like that in any battle operation, but you can't blame a man for wishing.

So far as it can, nevertheless, the Army tries to back one communication line up with another, and to give double or triple protection for vital messages.

In a typical divisional front there will be teletype, telephone, and radio circuits from Army to Division HQ, and where possible, teletypewriter from the rear to the front echelons of the division itself. Telegraph lines are laid to the infantry and artillery commands, and from regiment to battalion HQ. Phone circuits are laid to the regiments and divisional artillery, and from the regiments to battalions. The usual arrangement in setting up wire circuits is that the higher unit takes the responsibility of laying its wire to the lower (and more advanced) unit. Telephone exchanges range from the divisional board, with 60 or 80 connections, to the regimental field exchange, with 12 drops, and the small battalion board with six.

"HANDIE-TALKIE" portable set is the latest refinement on the celebrated walkie-talkie. Used like a telephone hand set, it weighs less than 10 pounds and can be carried right along with advancing infantry

Radio nets from the division HQ include infantry regiments, artillery battalions, cavalry reconnaissance units, and any special supporting troops, such as cannon company, anti-tank company, engineers, military police company, or the like. Infantry regiments have radio nets to their battalions, and the battalion will have handie-talkie radio circuits to its companies.

The total communications equipment of a modern division is a massive setup. The signal Corps has the responsibility of in-

TAKEN FORWARD BY JEEP OR BY HAND

For directing fire from advanced positions, the staticless radiotelephone works in the front line. When the going gets too rough for the jeep, two men can carry the 100-pound outfit, as shown at the right. In a pinch, it divides into two parts for carrying by one man as above. Batteries power it when it is away from the jeep's current supply

stalling and operating all communications equipment from the top command down through the regimental echelon. More advanced units operate their own communications, but with equipment developed, tested, and procured for them by the Signal Corps.

No one should get the idea, however, that Signal Corps men do all their work far behind the battle line. On the contrary, their service is extremely hazardous; few military objectives can expect to receive more attention from the enemy than communications crews and installations. The World War record of the Corps speaks for itself. Out of a little more than 34,000 officers and men in the AEF's Signal Corps, 301 were killed and 1,721 wounded or gassed. Only the infantry had a higher percentage of casualties.

In this war, Signal Corps men are seeing even more vigorous action. The Corps is now training members of the Women's Army Auxiliary Corps to replace enlisted men as radio operators and mechanics at certain Air Forces installations; the men will thus be freed for front-line duties.

Americans have good reason to take pride in their Army Signal Corps. This branch of military service was originated by us and copied by all the other armies of the world. Signals—banners or horns—had been used by armies since the dawn of history, of course, yet little was done to organize signaling as a specialized technique until nearly a generation after the invention of the telegraph.

The world's first real Signal Corps was founded in 1860, shortly before the Civil War, when the U. S. Army granted the appointment and title of Signal Officer to a young Army surgeon, Major (later Brigadier General) Albert J. Myer.

Since then the Corps has continued to serve the nation in peace and war. Among its peacetime services was the establishment of the first national weather observation and forecasting service. No phase of war has developed more strikingly in modern times than war communications, and the Signal Corps has kept pace with that growth. Its men are serving again now, true to their terse combat motto: "Get the message through."

LOOK NORTH... AND SEE

How We Can Smash Japan with Bombers from Alaska

By ALDEN P. ARMAGNAC

Photographs from American Museum of Natural History

What you see in a map depends upon how you look at it. Maps are the blueprints of global strategy. In these northern views of the globe there are three things that hit you in the eye: (1) The Arctic Ocean is an inland sea like the Mediterranean, but a sea dominated by the Allies. (2) Alaska is the great bastion of the north . . . a base for invasion. (3) A sky highway points straight as a die toward Tokio.

SHALL we invade Japan? If the idea is bold, it is on no less grand a scale than the general objectives of the United Nations in the Pacific. To attain those objectives, we obviously will have to:

Strip Japan of the mandated islands that she accepted as a trustee, and fortified for keeps.

Evict her from the vast territories now overrun by her barbarians in modern dress, and restore them to their rightful owners.

Disarm her of warships, guns, and planes.

Eliminate from ruling power the military clique, responsible only to an acquiescent Emperor, that has made her the trouble-maker of the Far East.

For months after Pearl Harbor, however,

STEPPINGSTONES TO ASIA. At the Bering Sea, the vast Pacific narrows to a strait across which American and Siberian territory face each other in easy viewing distance. Farther south, the curving chain of the Alaskan Aleutians stretches from the North American mainland to within 750 miles of the nearest Japanese territory—Paramushiru, the naval base at the northern end of the Kurile Islands. From Paramushiru, the Kuriles stretch southwestward to the main islands that are the heart of Japan's empire

TOKIO

FAIRBANKS

CHICAGO

AIR LINE TO TOKIO runs straight as a die from the center of industrial America across Alaska to the vulnerable vitals of the Nipponese war machine. Short-range planes must push bases forward along the island steppingstones; long-range bombers can fly from Alaska

MARE NOSTRUM Mediterranean of United Nations strategy is the Arctic Ocean. Located in the center of the warring powers its littoral is almost exclusively in Allied hands. Soviet ice breakers have even opened its Siberian coast line to navigation

BRITISH ISLES

SCANDINAVIA

SEA ROUTE

ICELAND

U.S.S.R.

GREENLAND

NORTH POLE

ARCTIC OCEAN

ALASKA

CANADA

we were able to wage no more than a defensive war. The turning point came with Guadalcanal in the Solomons, where the cream of our fighting forces dominated the island after months of fighting the Japs. "From now on the going will be tougher," says Admiral Chester W. Nimitz, Commander in Chief of the United States Pacific Fleet. "It is our job to destroy the enemy's ships and planes and to neutralize his islands' strong points, as we drive toward the positions from which we can reach with our shells and our bombs his industrial nerve centers."

How long will it take? Because we can build ships faster than can Japan, our margin of superiority in warcraft and cargo vessels grows constantly. But time is not wholly on our side, for it enables the Nipponese to fortify and consolidate their conquests. And every year of war adds to our mounting toll of blood and treasure.

From China, a powerful air offensive might be launched at Japan—if the doughty Chinese only had the planes, the gasoline, and the bombs. The problem is how to get United Nations aid to blockaded China, other than in driblets by air over the perilous Himalayan route from India. Recapture of Burma and its famous road has become an avowed Allied aim—but, again, how long will it take?

Speculation shifts to an assault on Japan from a direction that ordinary maps hardly suggest, but of which Nippon itself is acutely and nervously aware. The jumping-off place is Alaska.

As for the mechanics of such a plan, the comparatively short range of fighter and torpedo planes suggests an advance by the steppingstones of the Kurile Islands, starting with the seizure of Paramushiri—Japan's northernmost naval base. This would be done with the co-operation of a naval task force, including aircraft carriers. On the other hand, unescorted bombers and transports—which have proved their ability to evade Zero fighters—could fly nonstop from advanced Alaskan bases to Japanese islands. Landing places in China would augment the load of bombs or troops they could carry. Given time to build them, enormous aircraft as large as, or larger than, the Army's experimental Douglas B-19 and the Navy's Glenn Martin flying boat Mars would be especially suited for the task, with their range of almost 8,000 miles.

So far, Soviet Russia has been left out of the question, since it has not declared war upon Japan at the time these words go to press. But if this day-to-day neutrality should suddenly end, or if we were to have the use of Red air bases, our attack would become infinitely simpler.

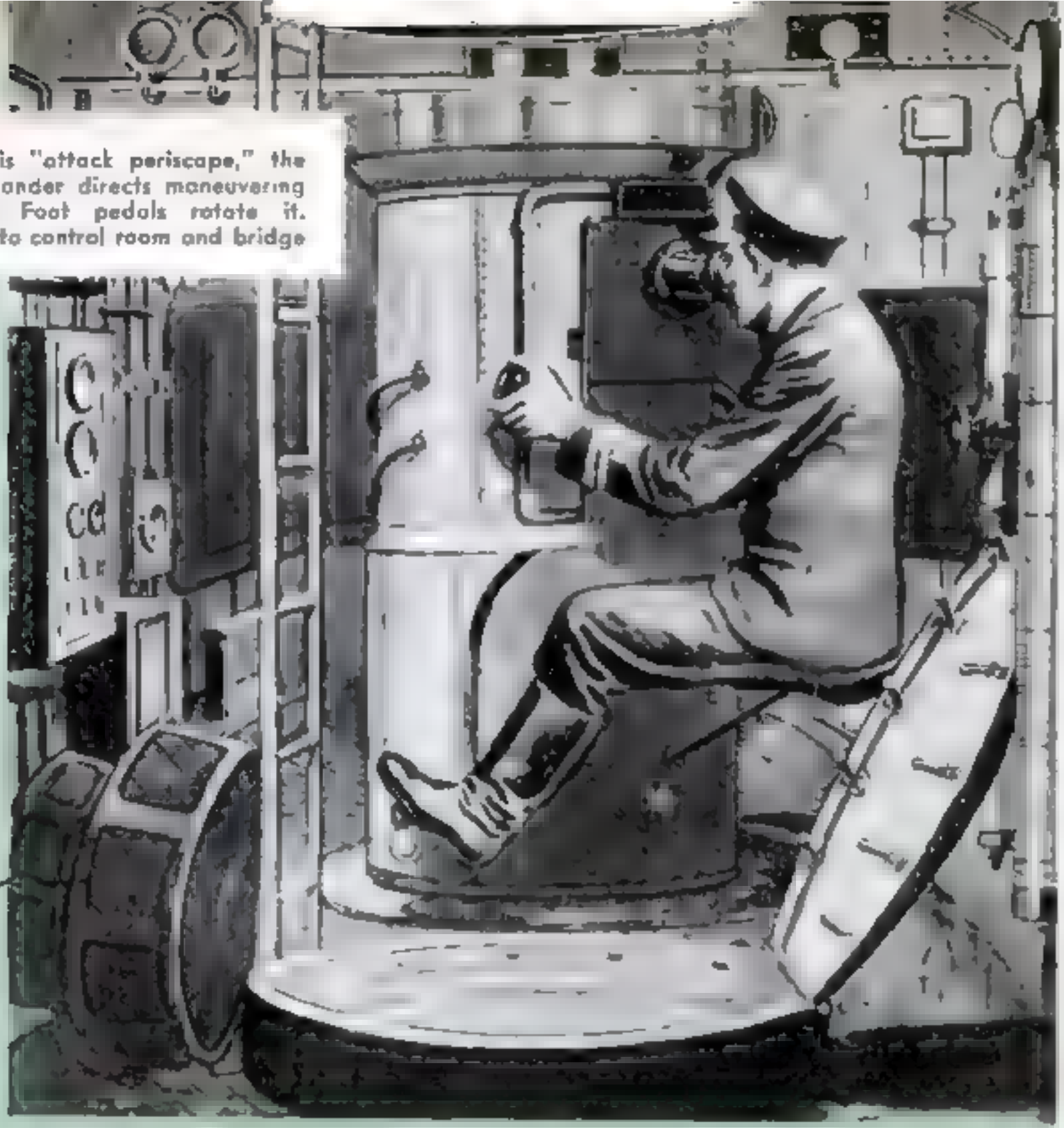
Bombers, bombers, and more bombers—these are the weapons that commend themselves to take the fight out of the Japanese. A single raid on Tokio was enough to give them jitters. Imagine, then, the effect of round-the-clock bombing with everything we have. Even comparatively light planes could sow enough incendiary missiles to wreak havoc among the tinderbox structures of Tokio. Heavy aircraft would carry "block buster" demolition bombs to raze their naval bases, their industrial centers, their seaports, their airports, and their railroad lines. Let us have no compunction about leveling everything that comes beneath the bomb sights. We have only to remember the fire-swept shambles that Nipponese bombers left of Shanghai, at the very beginning of their undeclared war against China, to know we will be speaking the only language that the Japs understand.

Japan presents almost an ideal bombing target. Although the total area of her principal islands is more than half the size of Germany, most military objectives are concentrated in four small sectors. Hit Tokio and its harbor, Yokohama; Osaka and near-by Kobe, respectively the largest city and leading seaport of the country; Yawata, vital steel center; and the shipyards of Nagasaki. That is the simple formula for knocking out the enemy.

Granted an element of luck and surprise, our bombers and torpedo planes might turn the tables of Pearl Harbor, and save our Navy considerable trouble in dealing with the Japanese battle fleet. Rightly or wrongly, opinion has been advanced that if the Japs had pressed home their temporary advantage at Hawaii, their flag might now be flying over the islands. By the same argument, a bombing barrage upon Japanese defenses could prepare the way for an invasion in force. Seize or destroy the centers of supply for Japan's overseas contingents, and most of them would be at the mercy of hostile peoples.

At the top of the world, everyday geography turns topsy-turvy. Look at a map of the polar regions, and you will see our strategic "Mediterranean"—the Arctic Ocean. Well might it be called *Mare Nostrum*—our sea—since, with the sole exception of Scandinavia, its entire rim lies in the hands of the Allied powers. Aviation makes it a short cut to all parts of the Northern Hemisphere. Soviet ice breakers have even opened a shipping lane along the northern shore of European Russia and Siberia.

Now look a little southward, where the Bering Sea joins the Arctic and Pacific Oceans. The vast expanse of the Pacific all but closes. Little *(Continued on page 202)*



Seated at this "attack periscope," the U-boat commander directs maneuvering for the kill. Foot pedals rotate it. Hatches lead to control room and bridge

POPULAR SCIENCE BRINGS YOU

The SECRETS OF NAZI U-BOATS

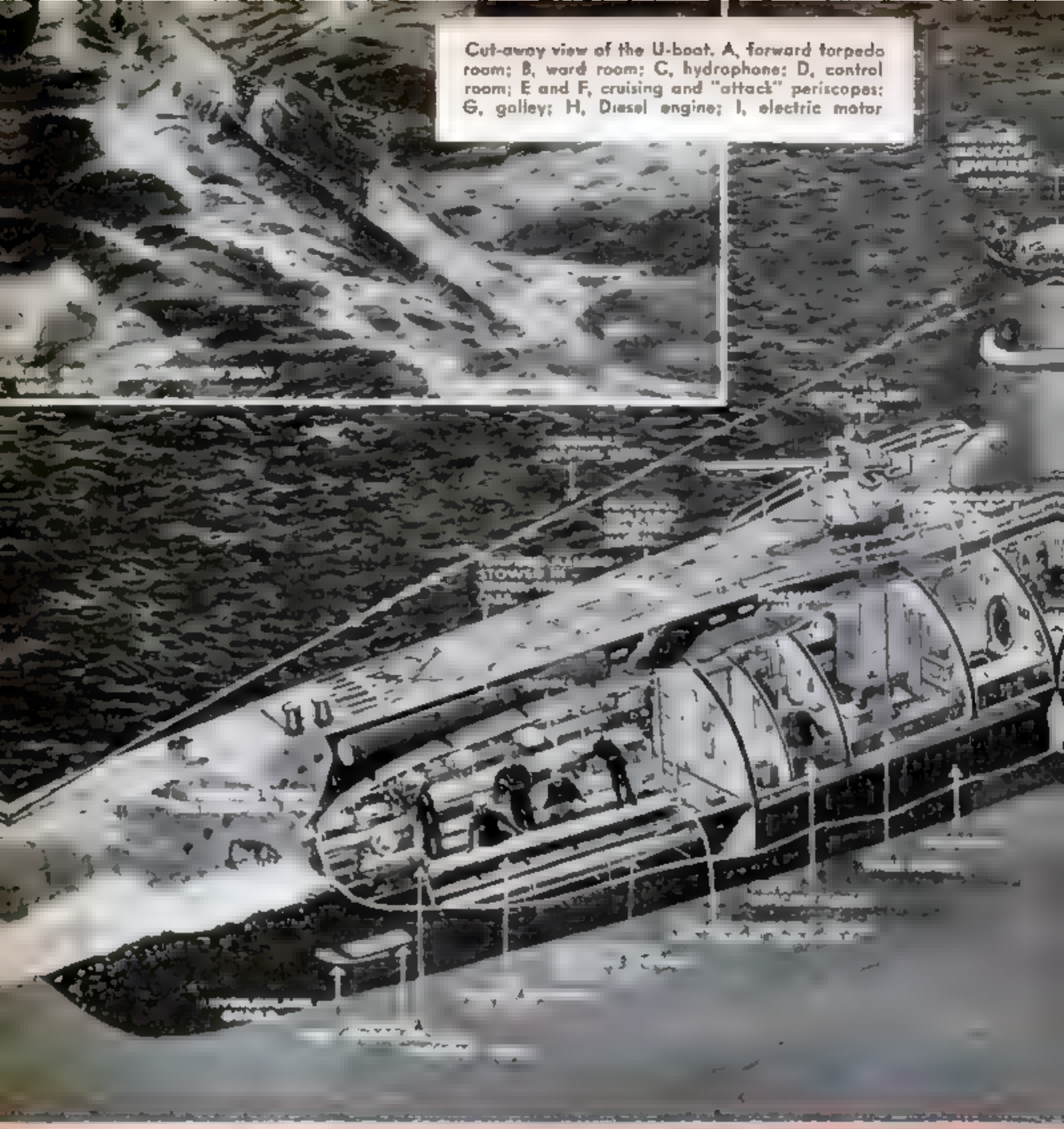
THESE UNDERSEA WOLVES, BUILT AS DEADLY PROWLERS, SACRIFICE THEIR CREWS' COMFORT FOR SPEED AND PUNCH

CAPTURED intact by the British, a German U-boat now reveals the secrets of the coastal type that Hitler has been building in large numbers to prey upon ships approaching England.

Moderate in size, for speedy construction, the 221-foot-long submarine carries a crew of about 45 officers and men. On the surface, it displaces 773 tons and travels at about 17½ knots, enough to overtake all but the fastest cargo vessels, under the power of twin Diesels. Submerged, with its displacement increased to 882 tons, it makes about eight knots, driven by electric motors.

Armament consists of four bow torpedo tubes and a single torpedo tube astern. These all are loaded at the start of a voyage, and seven additional torpedoes are carried, making a total of 12. To conserve these valuable missiles, a 4.1-inch deck gun disposes of helpless, unarmed vessels. An anti-aircraft gun of smaller caliber, just aft of the bridge, combats the serious danger of attack by planes. The pressure hull is made circular to give the vessel strength against depth charges, and two "bulges" high on port and starboard give further protection.

For hunting its victims, the sub is provided with a hand-operated cruising periscope with interchangeable lenses. A wide-



Cut-away view of the U-boat. A, forward torpedo room; B, ward room; C, hydrophone; D, control room; E and F, cruising and "attack" periscopes; G, galley; H, Diesel engine; I, electric motor

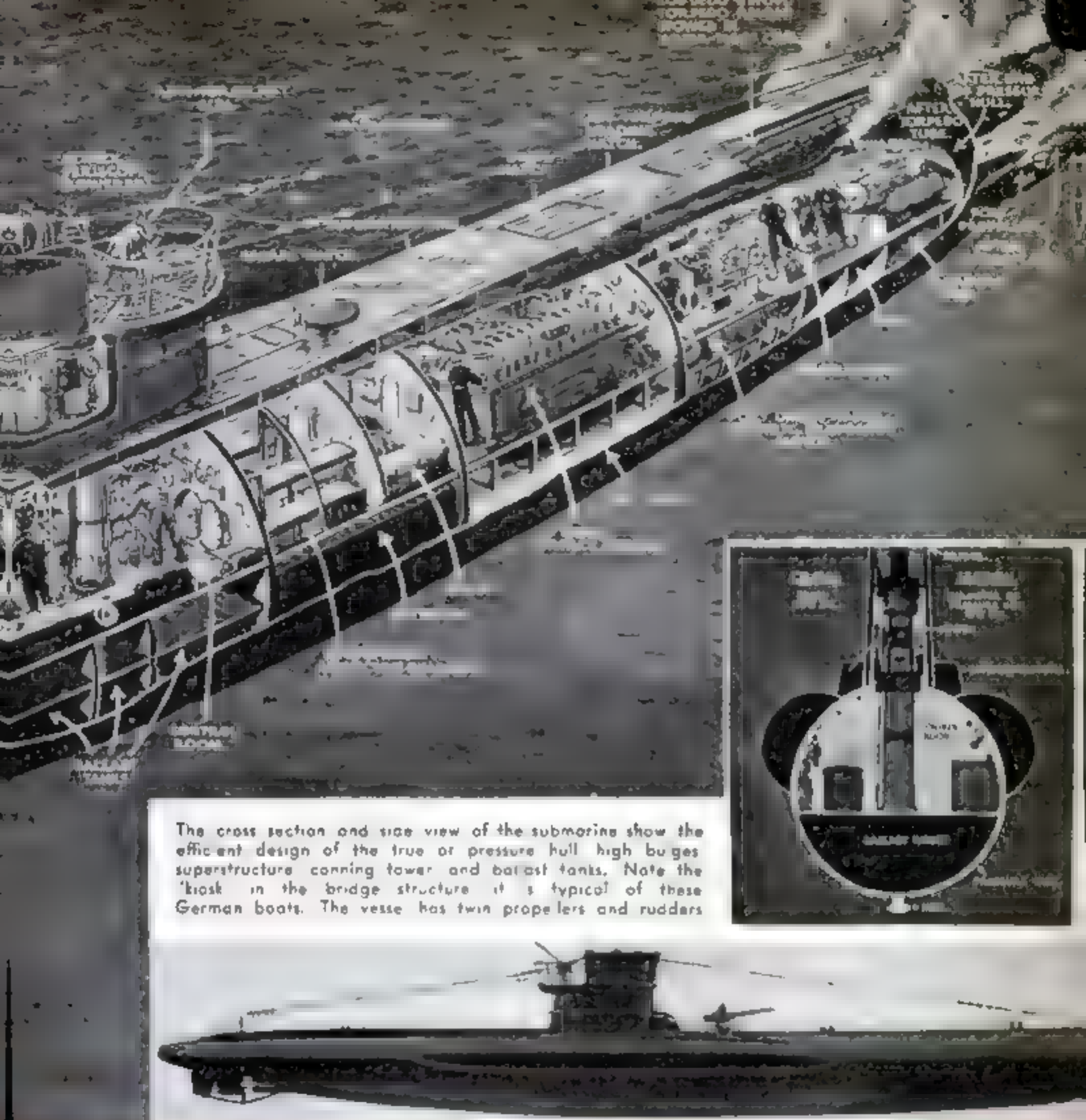
GERMAN UNDERWATER CRAFT ARE EQUIPPED FOR FINDING PREY,

angle eyepiece gives a broad view of the horizon to detect telltale smoke trails. Switching to a telescopic eyepiece then permits identification of a particular vessel.

As the U-boat closes in on the ship, the commander takes his place at a massive, electrically driven "attack periscope" which he trains by foot controls. Without moving from his seat, he can revolve in a full circle. Through voice tubes, he issues steering and firing orders to the men below.

An additional aid to the underwater raider, a multi-unit hydrophone detects the beat of a distant ship's propellers. Red and green lights, appearing on a graduated dial of this sensitive instrument, betray the position of the surface ship. This permits the periscopes to be retracted, in clear weather when their wake would be visible, and enables the submersible to make its attack while completely under the surface.

By special permission of the Admiralty,

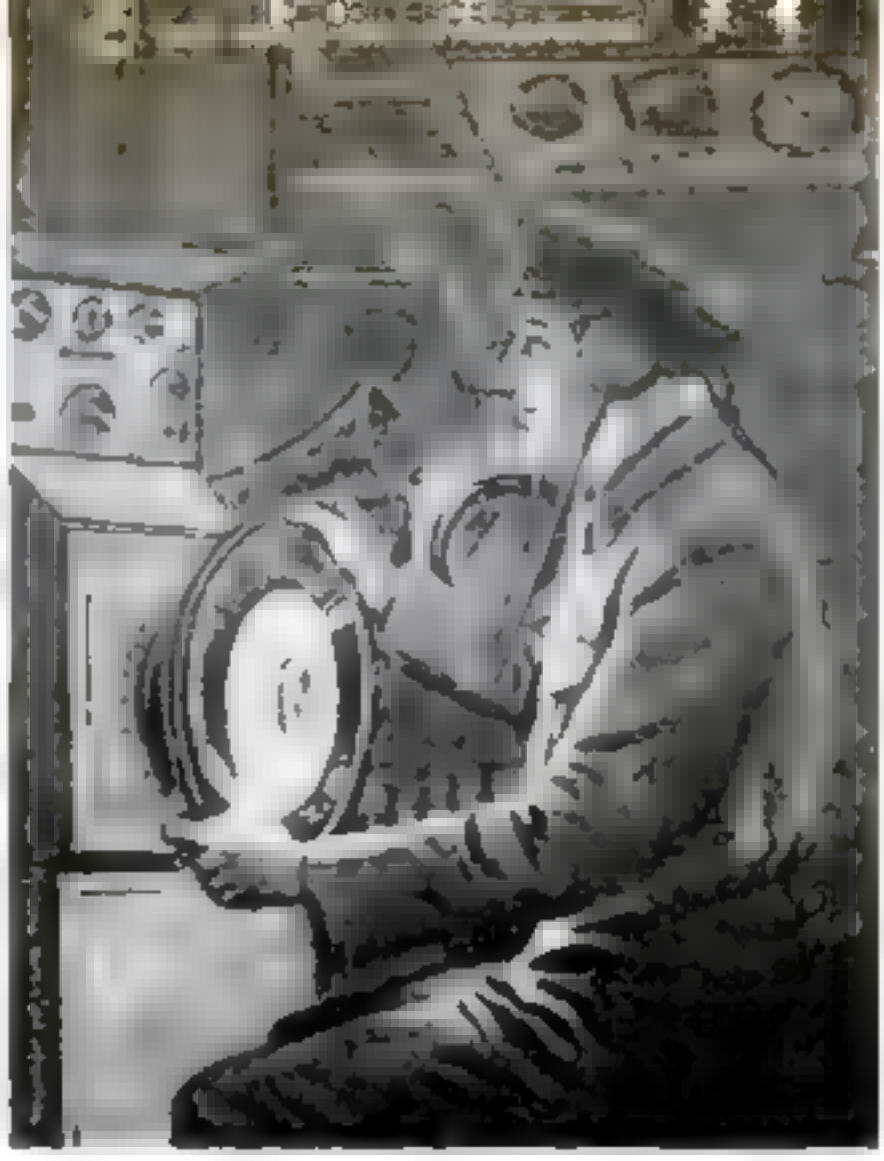


The cross section and side view of the submarine show the efficient design of the true or pressure hull high bulges superstructure conning tower and ballast tanks. Note the 'kiosk' in the bridge structure it's typical of these German boats. The vessel has twin propellers and rudders

STALKING IT DOWN, AND FOLLOWING THROUGH FOR THE KILL

The forward torpedo room serves also as crew's quarters. Torpedo tubes are in the background, torpedoes on the floor

Interchangeable lenses give the U-boat observer wide-angle and telescopic views (left to right, above). They are in the cruising periscope below



This sensitive hydrophone detects propeller beats and registers a hunted ship's position with red and green lights on an elaborately graduated dial

G. H. Davis, well-known British artist, was allowed to go aboard the captured U-boat and make a remarkable series of drawings, which are reproduced here through the courtesy of *The Illustrated London News*. They give a revealing picture of the craft that menace the Atlantic seaways.

Looking aft in the control room, where orders are received from the commander during an attack. Every inch is used for dials, gauges, and controls. The cruising periscope is seen lowered into its well

Angora rabbit hai seven times warm than sheep's wool by weight, and it wears well if treated with care. A sweater made of Angora should be shaken out well after each wearing. When washed, it should be gently wrung out in a towel, dried, shaken out, and then brushed to bring up the nap. At left are three of the rabbits that Mrs. Johnston has raised in her own back yard

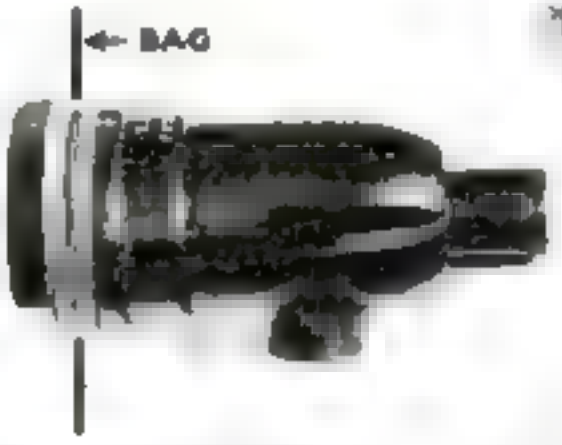
Photographs by Robert F Smith

Holding the rabbit in her left hand, Mr Johnston snatches out a clump of hair wi her right. Plucked hair makes better ya because it is longer and its ends are t pered. The long, silky hairs shown belo are ready to be washed and spun into ya

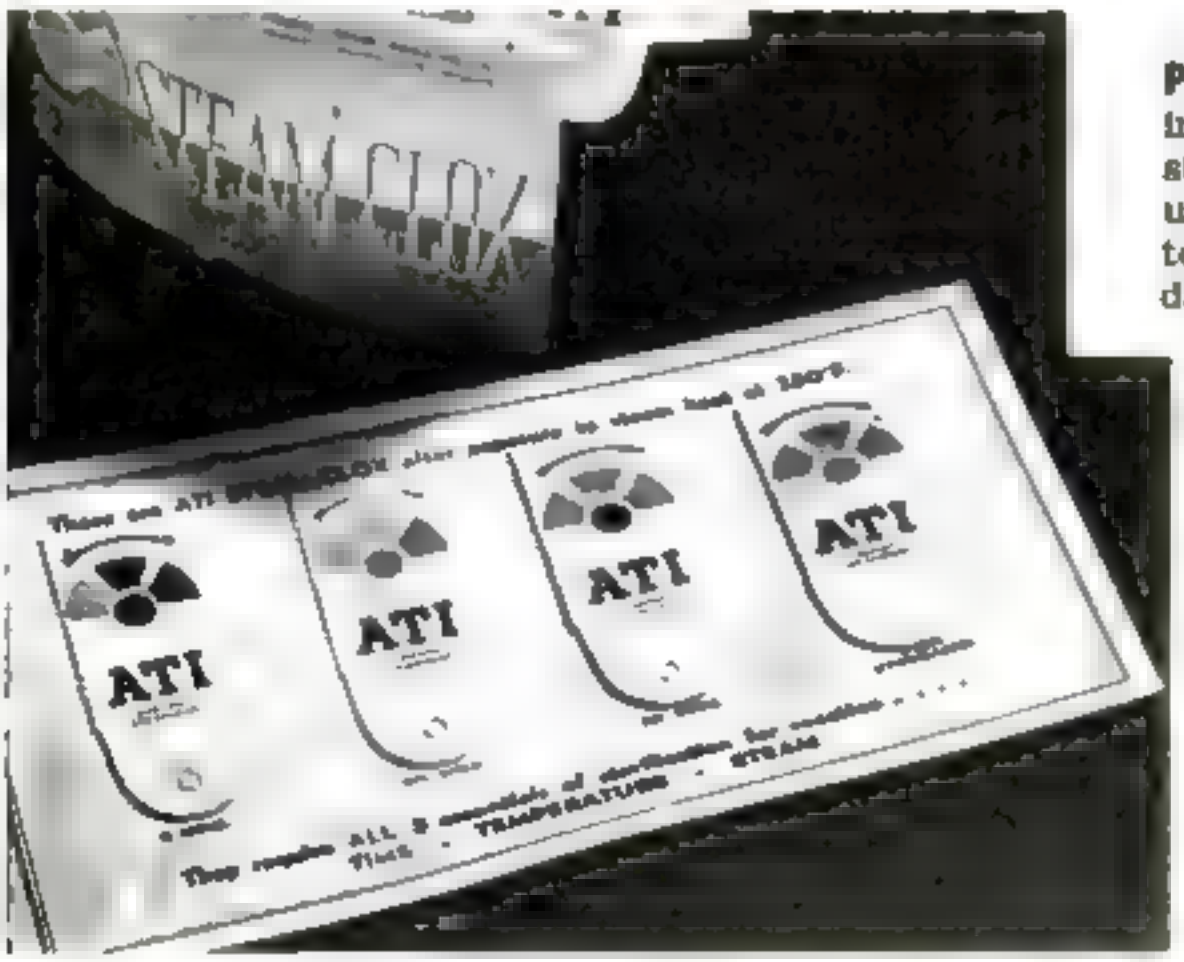
ANGORA rabbits raised in the back yard of her Bayside, N. Y., home supply Mrs. Betty Johnston with hair which she knits into sweaters. Each rabbit is plucked five times a year, four pluckings yielding about nine ounces, which is enough for one garment. After being washed, the hair is made into a sturdy, fuzzy yarn on an old-fashioned spinning wheel, and then knitted into a sweater in about 20 hours.

The hair is fed to the spinning wheel in generous and deliberately uneven wads to make the yarn sturdy and to give the final garment an attractive "handmade" look. The yarn is then knitted into a sweater in the same manner as wool

TWO-WAY POST CARDS are a novelty being put out by James Gray, Inc., of New York, to make correspondence easier for service men. A friend writing to a soldier uses only the upper half of the folded card. When the soldier gets it, he tears off that half, writes his reply on the lower half, and returns it. The cards require only one-cent postage.



PLASTIC FAUCETS are replacing those of critical brass on the sterilizer bags that the Army uses for purifying drinking water. The new faucets avoid the danger of corrosion



INDICATORS that time the sterilization of materials at 250 degrees F. are made by the Aseptic-Thermo Indicator Co., of Los Angeles. Purple sections on these paper tabs change to green after five, 12½, or 20-minute exposures. A safety spot changes color to warn of overexposure and possible deterioration of materials.

STEEL HALF SHOES fitted with reclaimed rubber bumpers are being worn by workers at Consolidated Aircraft plants as a protection against injury to their feet. The workers often have to handle heavy parts, which sometimes slip out of their fingers and land on their toes. Should a worker inadvertently walk into a heavy, solid object, the rubber bumpers cushion the blow. Corrugations give added strength to the shoes, which are strapped on.

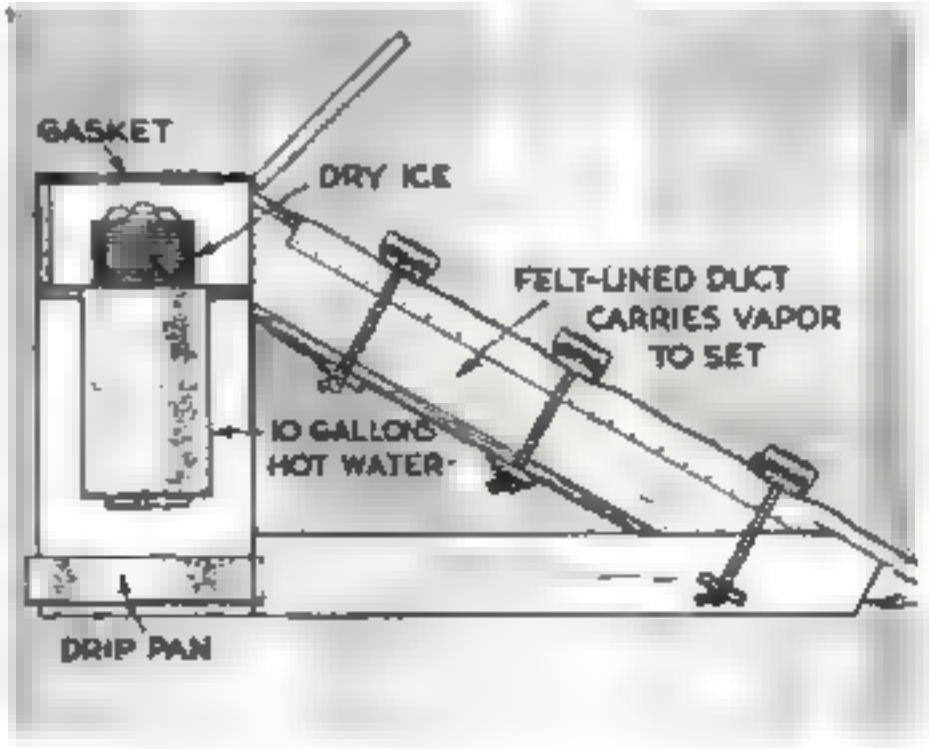
A mist, sprayed from an air gun, adds to the illusion of unreality

Cloud Cookers

PROVIDE DREAMLIKE SETTINGS FOR MOVIE FANTASIES

TO FLOOD a movie set with clouds, and thus create a dreamlike illusion in the scene, Clyne Jones, a "prop" worker in Paramount's studios, has developed a cooking device in which a wire basket filled with dry ice is dunked into a 10-gallon can of hot water. The fuming carbon dioxide that results is then blown onto the set by jets of steam, which can be controlled so as to flood the set to any desired depth. The clouds in the above scene—which occurs in the Ginger Rogers picture "Lady In The Dark"—required a battery of 24 cookers. Once the carpet of clouds was laid, a mist was shot into the scene with a compressed-air gun that expels a spray of chemicals developed in the laboratories of the University of California. Being extremely light, this spray can remain suspended in the air for several minutes. Technicolor and a sky-blue background helped to enhance the effect of unreality.

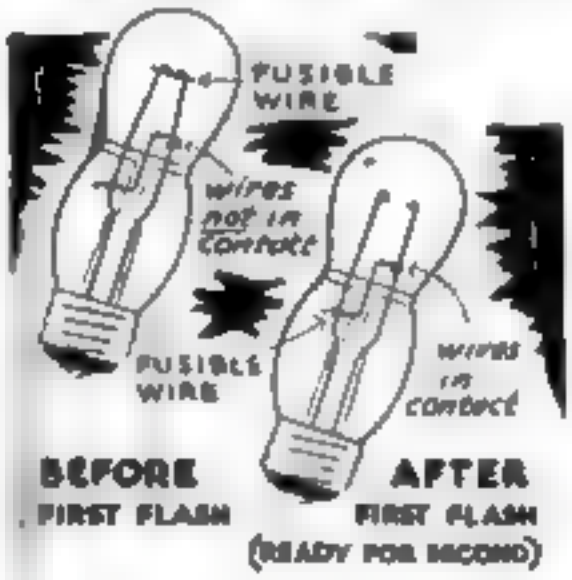
Hollywood "cloud makers" at work and, right, a diagrammatic view showing how a cooker operates



With the INVENTORS

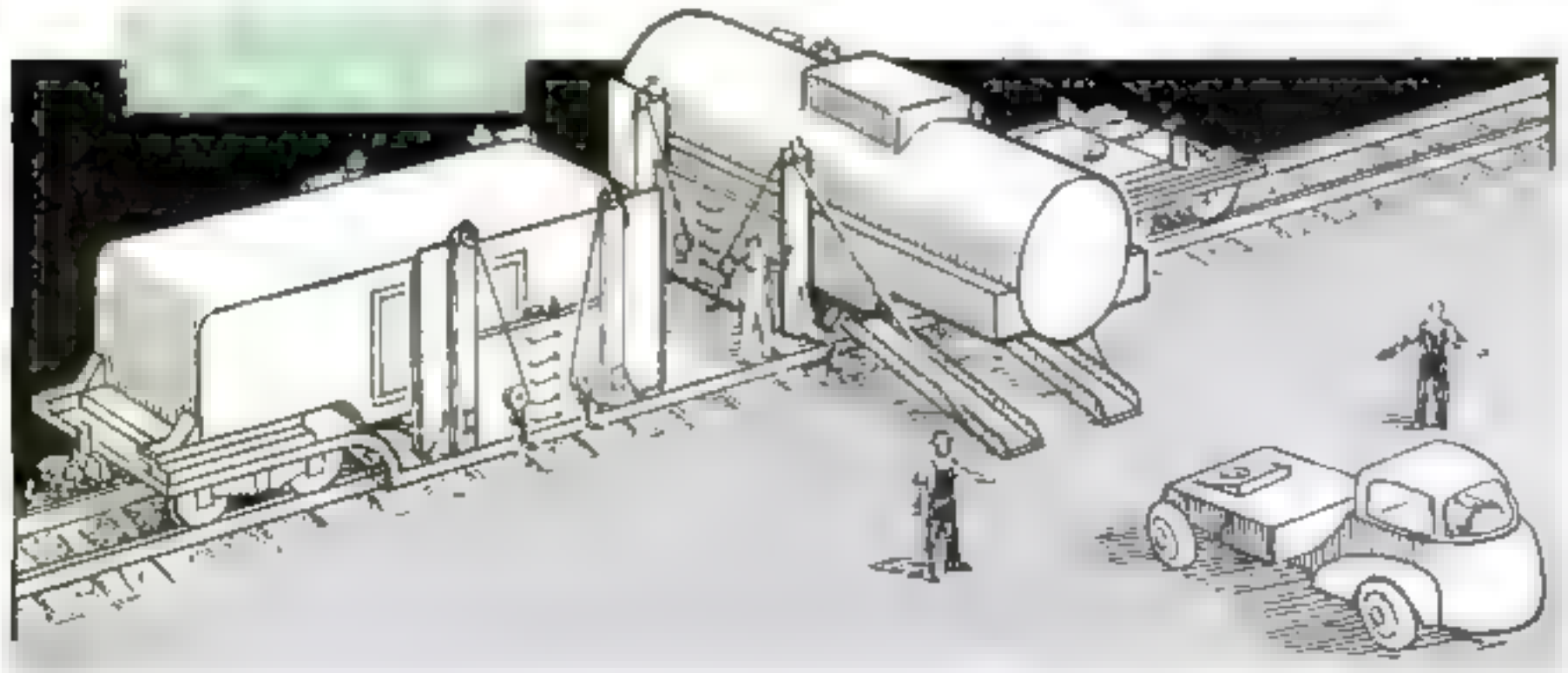
A LADDER whose legs will conform to uneven ground through a system of swivel joints is the subject of a patent by H. J. Myers, of Long Beach, Calif. Under the weight of the user, a locking mechanism holds the legs firmly in position. Release of the weight unlocks the device.

TO IDENTIFY check cashers in the event of error or fraud, J. A. Madden, of Vancouver, Canada, has invented a hidden camera that photographs the transaction when the cashier stamps a serial number on the check. The number automatically appears on an indicator and is photographed with a clock and a calendar.



TWO pictures can be made with a flash bulb developed by John Aquilla, of Brooklyn, N. Y. The first flash is produced by a fusible wire in the upper bulb. The electrodes then spring apart to make contact with a second wire—a quick-acting switch preventing pre-ignition.

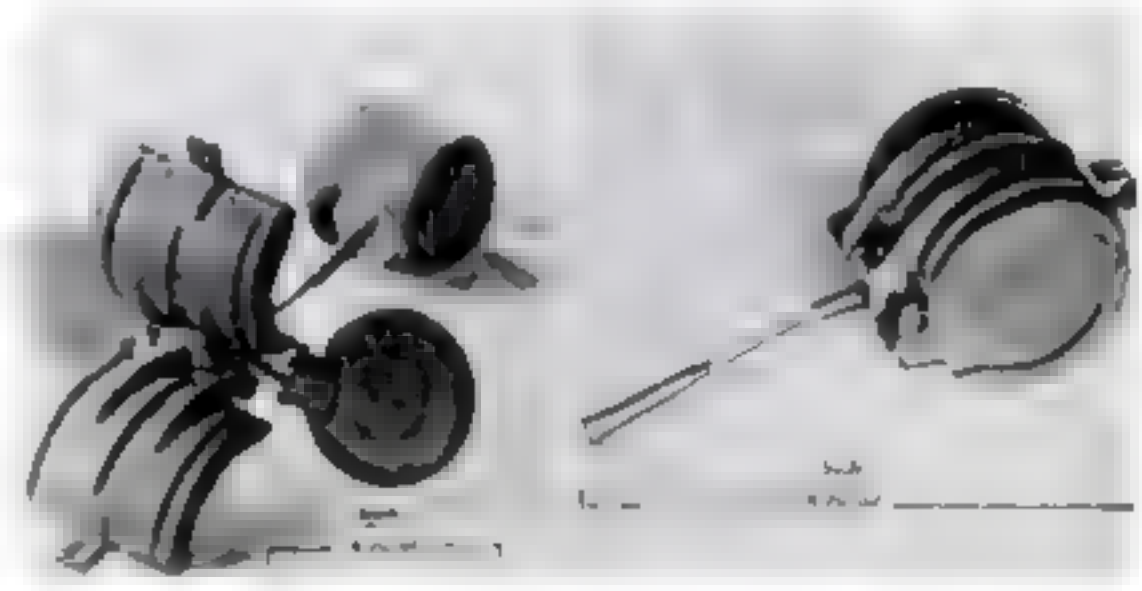
RIDING as well by road as by rail, a tank designed by Joseph F. Johnson, of Chester, N. Y., speeds delivery of milk. From the collecting center, the container travels aboard a truck trailer to the railroad where it is placed on a special well-type car with raised ends. Hoisting apparatus wheels the trailer and tank up two ramps and onto the car. The swivel deck is then rotated and secured parallel to the tracks. At the point of unloading, the procedure is reversed. The trailer and truck are rolled off the car and truck-hauled to the shipment's final destination.



GLASS RECORDING DISKS are the latest answer supplied by the phonograph industry to shortages of critical materials. The new disks are made on a transparent base of ordinary glass with a coating of slow-burning ethyl acetate. They were developed by H. & A. Selmer, of Elkhart, Ind.

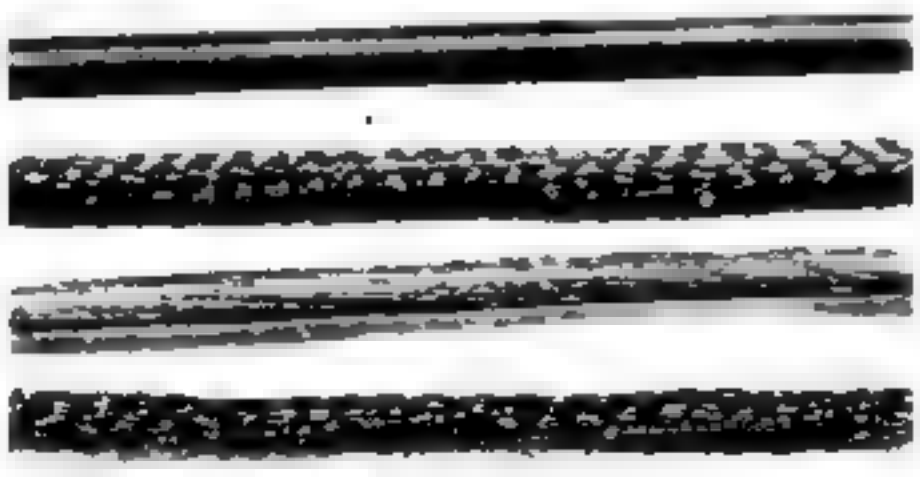
A PAPER-COLLATING MACHINE developed at the Nashville division of Vultee Aircraft, Inc., gathers 360 sheets a minute compared with the old rate of 75 per minute by hand. Mechanically operated, with foot-pedal control, the machine handles either legal or letter-size paper in two groups of six sheets each. Its 12 bins, arranged in two tiers, have a capacity of about 500 sheets each.

BUTTERFLY BOMBS are new and deadly 4½-pound antipersonnel explosives that Nazi planes have been dropping recently in considerable numbers on British towns. The bursting charge, probably containing a sizable amount of guncotton, is enclosed in a hinged case which is painted either grayish green or bright yellow. This case opens in the air, its four parts acting as vanes. Although the bomb is designed to explode on contact with the ground, many duds — called "UXB's" by the British—are found in the streets after a raid. Usually they are not fitted with time fuses, but they are decidedly dangerous to handle, being so sensitive that they are likely to go off with a touch in spite of having survived the jar of hitting the ground. As the effect of their detonation is purely local, the British have been taught to rope off the areas in which they land and to leave them for the expert handling of trained bomb-disposal workers.



The bomb case opens on hinges, its four parts acting as vanes

Closed, it resembles a coffee can with a short wire handle



SURGICAL SUTURES of nylon, developed by Du Pont plastics chemists, are being manufactured in millions of feet of monofilament similar to that formerly used for tennis-racket strings and fishing leaders. The nylon filament, shown at top in the photo at left, is a solid strand in contrast to the braided silk sutures shown below it, and is said to be nonabsorbent, inert, nonirritating, nonfraying, and nonsplintering.

THE Bulldozer Grows Wings

When the Army needs a front-line airfield, it needs it in a hurry. That's the reason for the Airborne Aviation Engineers — the brand-new service that flies in with its miniature earth-moving machinery to make new roosts for the fighters and bombers.

By ALLEN RAYMOND

WHEN United States troops invaded North Africa, they included a small group of soldiers the like of whom the world had never seen. They carried mechanized equipment which six months before had been merely a gleam in an engineer's eye. They were the first two companies of Airborne Aviation Engineers, of whom there are now many more.

Within nine days these two companies of airborne technicians with their novel equipment helped to capture and repair a bombed enemy airfield within a few miles of the West African coast, and to prepare two new fields in desert country a thousand miles

BIG-BELLIED CARGO PLANES CARRY FLYING ENGINEERS . . .

eastward on the Tunisian battlefront, along which our Flying Fortresses and fighter planes went roaring into action.

The organization of these airborne aviation engineers was a distinctly American contribution to the art of warfare. They were the brain child of Brigadier General Stuart C. Godfrey, Air Engineer, Directorate of Base Services, Army Air Forces. The General, a graduate of West Point in 1909, commanded an engineer regiment in France in World War I; and between military assignments in peacetime wrestled with engineering jobs on rivers and harbors from Panama to Muscle Shoals. Aside from his engineering talents, he writes verse; he wrote the lyrics for the Army Engineers' Fight Song, for which his wife composed the music.

In the spring of 1942, the General was pondering the dictum of General Henry H. ("Hap") Arnold, that air power is a three-legged stool, of which the three legs are pilots, planes, and airfields. Without the fields, pilots and planes cannot operate. The effective range of bombers and fighters is not entirely determined by their flying speed and fuel capacity, but by the proximity of their bases to the enemy.

In global warfare, and particularly in island-to-island warfare in the Southwest Pacific, the General ruminated, aviation engineers should not be confined to the ground, but be able to fly up fast to distant fronts for construction, repair, and maintenance of fields; just as fast as airborne infantry or paratroops could seize a base for them, or even faster in some situations. The major obstacle to this engineer's dream was the size of all standard types of earth-moving machinery. It was far too large to be flown in airplanes. The major problem, therefore, was to design such machinery on a much smaller scale

On May 14, 1942, the General wrote a letter to the Chief of Engineers, U.S.A., asking for help in implementing this idea. On June 8, a conference was held in his office in Washington, at which two men were assigned to develop plans for the new equipment, and a table of organization for airborne engineer battalions who could use it. These two men were Lieutenant Colonel Elsworth Davis of the Engineer Board, the Army Engineers research organization, and Lieutenant Colonel H. G. Woodbury of the Aviation Engineers.

With the enthusiastic help of manufacturers scattered throughout the country, earth-moving machinery tailored to airplane measurements was designed, built, and placed in the hands of troops within four months. The C-47 transport plane was then the only available plane for carrying such equipment. A capacious cargo carrier, this plane has a side door about seven feet wide by five feet high, and had already proved useful in carrying paratroops or airborne infantry with jeeps or other heavy equipment.

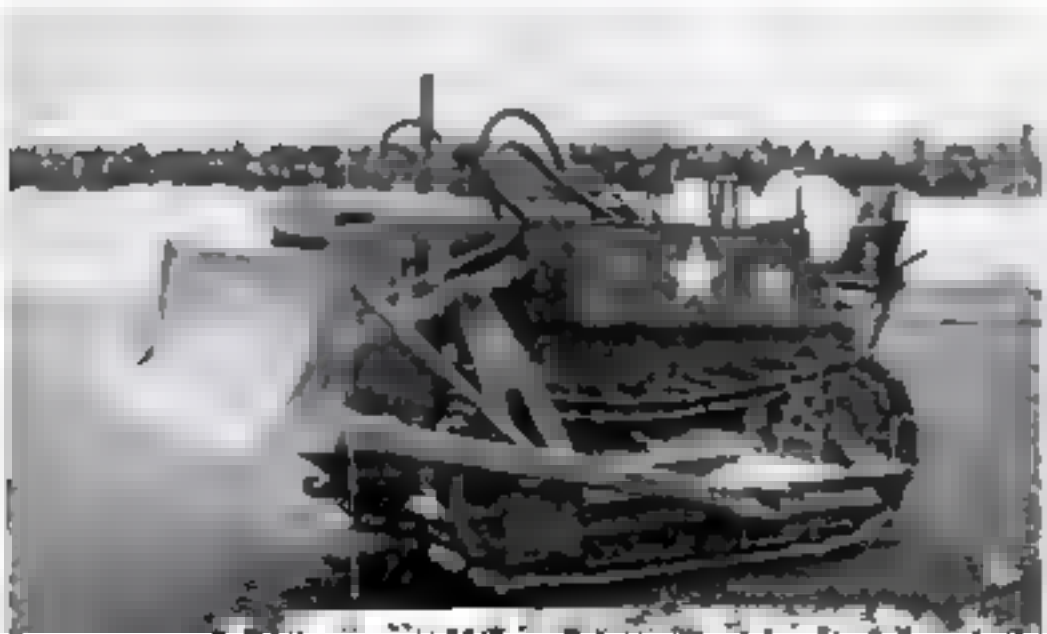
Small-size bulldozers, scrapers, tractors, graders, rollers, and asphalt heaters and distributors were built to the limitations of that airplane.

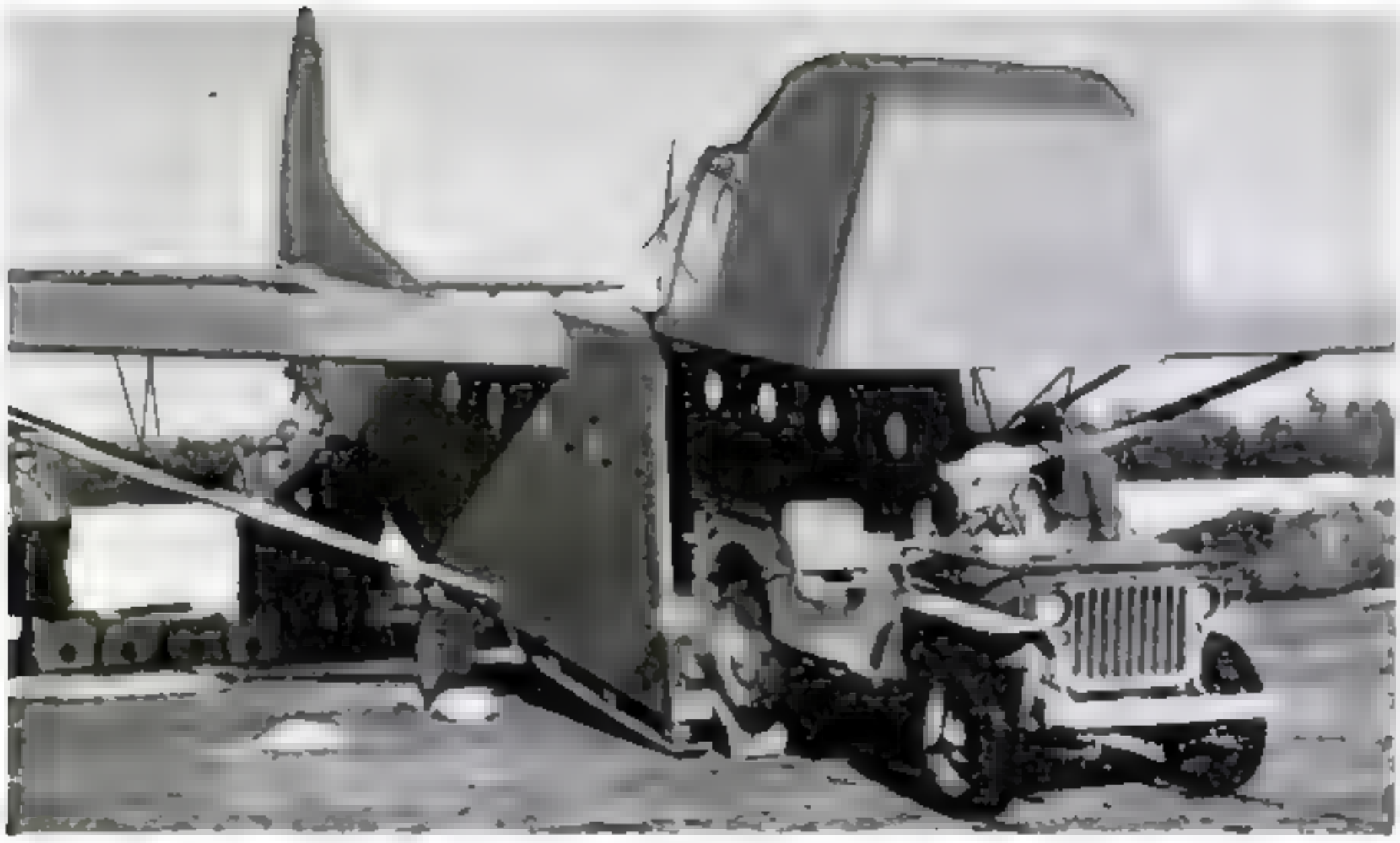
The bulldozer, as its name implies, is an instrument to push aside obstacles such as dirt, stones, and trees, and to level the land over which it travels. It consists of a tractor with a blade like that of a snowplow. A standard bulldozer, such as is used by Army engineers in general, weighs about 10 tons and has a 10-foot blade. The new miniature bulldozer, adapted for America's airborne aviation engineers from a model used by the U. S. Forestry Service, weighs only about 2¼ tons, has a blade slightly more than six feet long, and can easily be driven on a ramp through the door of a cargo plane.

Standard bulldozers have commonly used Diesel engines for fuel economy. The airborne models are powered by gasoline engines, so that the fuel will be the same as in other Army mechanized equipment.

A new carryall scraper was designed, which is a combination blade and dump cart, used to level elevations in any terrain where a runway is being built, and to fill in depressions. Standard scrapers for the groundling engineers have been of eight-yard capacity. They can dig up and haul away eight cubic yards of earth. The miniature scrapers for the airborne engineers

. . . AND MIDGET MACHINES TAILORED TO FIT FUSELAGES





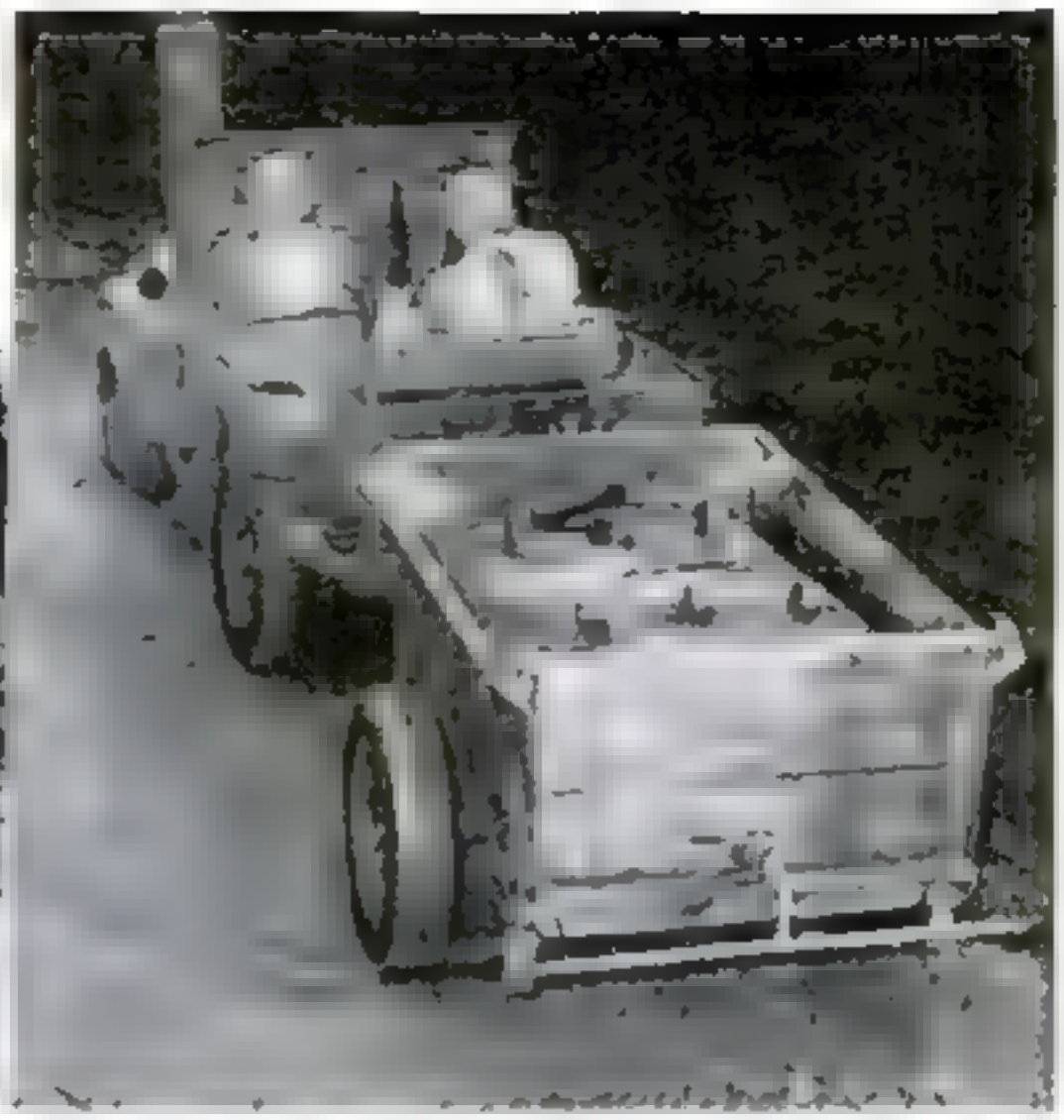
Specially constructed gliders, too, carry mechanized equipment. Here a jeep backs in under the nose

are of 1¾-yards capacity. Other new equipment included a grader small enough to be pulled by a jeep, and an asphalt heater little larger than some office desks. There was also a new-type roller, just a hollow metal drum to be filled with water or sand on the scene of operations. Empty, this drum weighs about a ton. Filled, it weighs more than three tons. A novelty in this Army-designed roller is its attachable "sheep's-foot" studs. These studs can be fitted to the roller on metal bands; as the roller revolves, they can tamp and compact an eight-inch layer of earth. Specially designed water purifiers and lighting units were also produced.

The first table of organization for the airborne aviation engineers was submitted by Lieutenant Colonel Woodbury on July 9, 1942, and on August 18 the Adjutant General directed the First Air Force to activate the First Provisional Airborne Engineer

EARTH-MOVERS THAT PLANT AIRFIELDS NEAR FRONT LINES

Midget dump trailers double as water carriers, with the addition of cells made of thickol synthetic rubber. An attachment at the rear provides a distributor bar for sprinkling, as below, and a faucet from which water can be drawn for troops. At right, a jeep is pulling the trailer

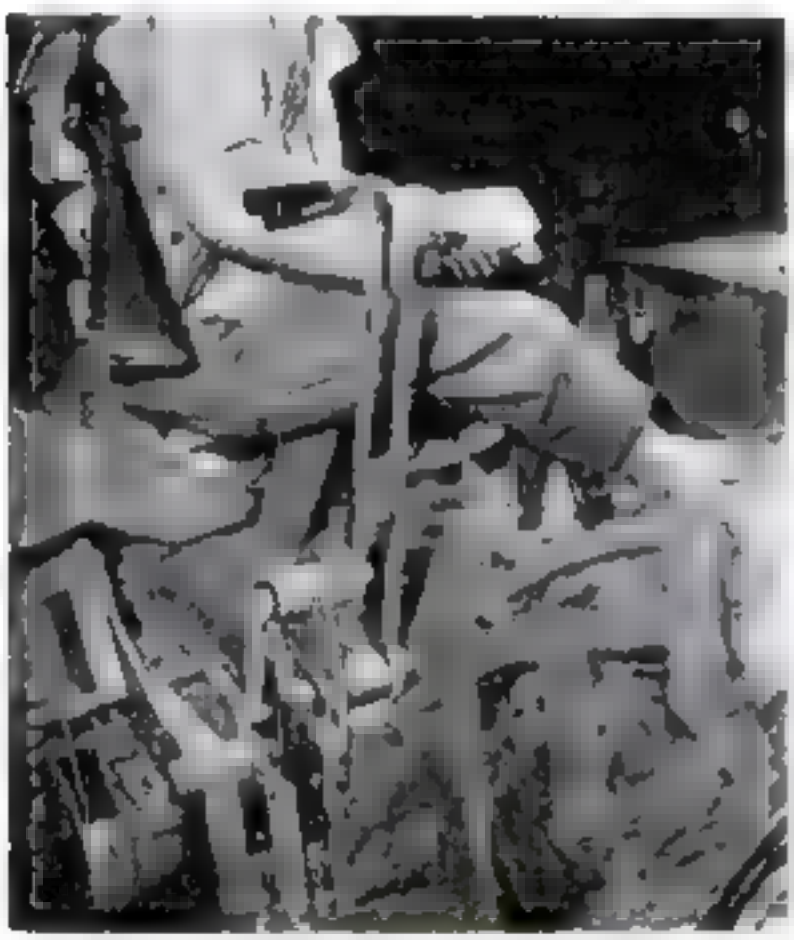


Aviation Battalion at Westover Field, Mass., with a cadre, or skeleton organization, composed of 100 volunteers from existing aviation-engineer units. To help train this command, and to carry equipment for it, the Troop Carrier Command provided several C-47 planes.

On August 29, Major General Jimmie Doolittle, who was to command American air forces in the initial African invasion, said that if these new-type engineers could be prepared in time he wanted them. A commitment was made to have two companies ready. As fast as the equipment rolled from the factory assembly lines, it was flown to Westover Field, and on October 8, just four months from the initial planning conference in General Godfrey's office, these two companies, completely trained and equipped, left Westover Field for an embarkation port.

On November 8, the first company of Airborne Aviation Engineers were part of a

ARE DESIGNED FOR EASY OPERATION WITH LITTLE MANPOWER



The carryall at far left is a vest-pocket edition of the famous Tournapull (P.S.M., Jan. '42, p. 52) with capacity of 1½ yards. The machine illustrated is fitted with a bulldozer blade. Simple controls enable one man to drive and operate it. The levers shown at left work the apron control and pan hoist. The horizontal control handle in center, below, steers the machine through clutches driving the big front wheels

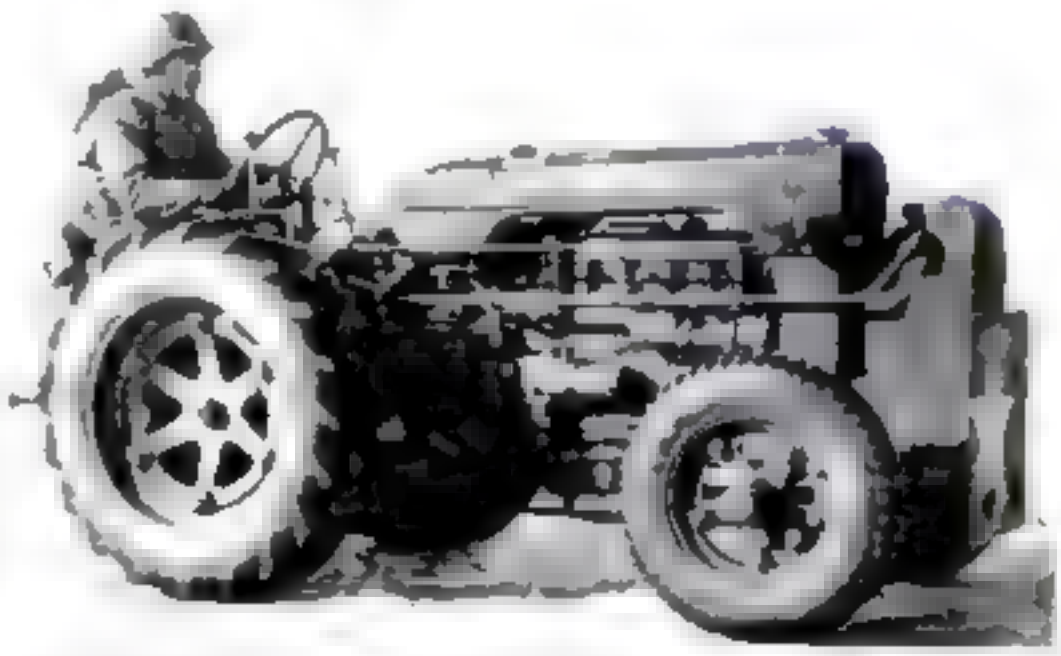
How a tractor is stowed in the belly of a C-47. Besides carrying its own load, the plane can tow a glider

combat team which landed on a hostile coast near Port Lyautey, Morocco. They rolled their toy equipment inland, and within a few hours suffered their first casualties while helping to storm an inland airfield which U. S. Navy flyers had rendered useless with their bombs, but which was still defended. The defense once shattered, these fledgling engineer troops worked 16 continuous hours, filling in craters left by the bombing. The next morning American P-40's were flying from the field.

Three days later, some 50 big cargo planes dropped down on that field, as "a present from General Doolittle." The General said he wanted two fields built fast on the Tunisian desert, just as close to the enemy as practicable.

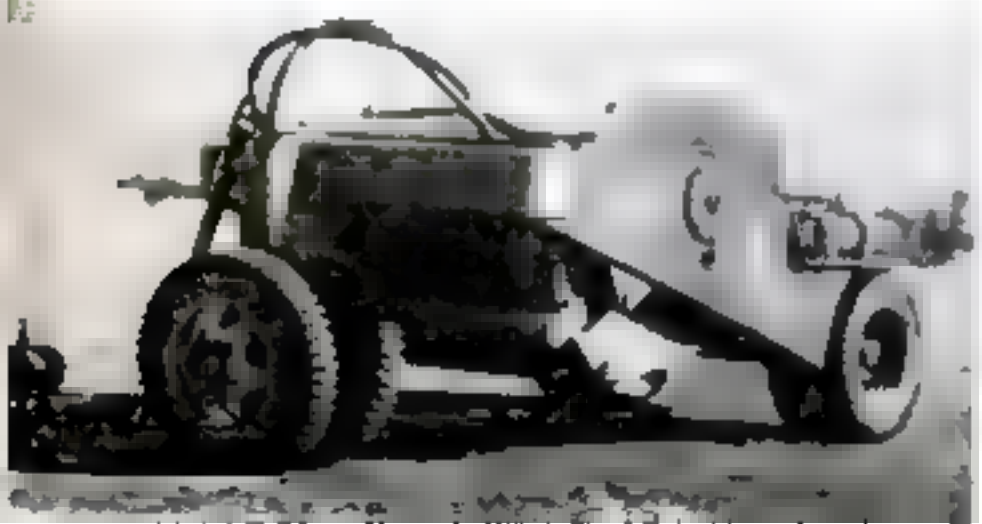
Between Port Lyautey and the sites picked for these airfields lay 1,000 miles of desert, spanned by a single highway and a tiny railroad. Highway and railroad were jammed with British and American troops and matériel. Other engineer units nearer the front were wrestling with other jobs. The new airborne aviation engineers flew the 1,000 miles to the front, and within three days had a field ready for bomber operation. On the fourth day they completed a field for our fighter planes.

It takes a run- *(Continued on page 212)*

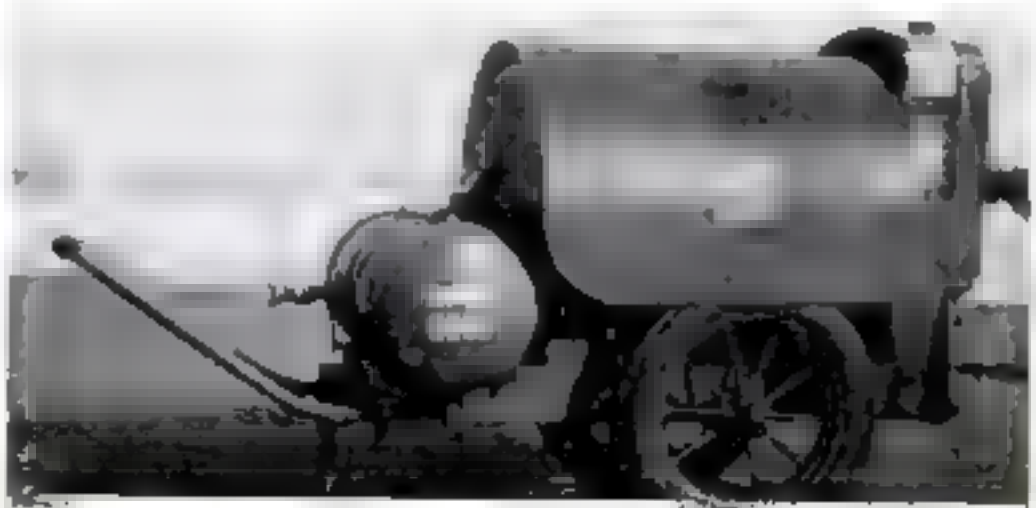


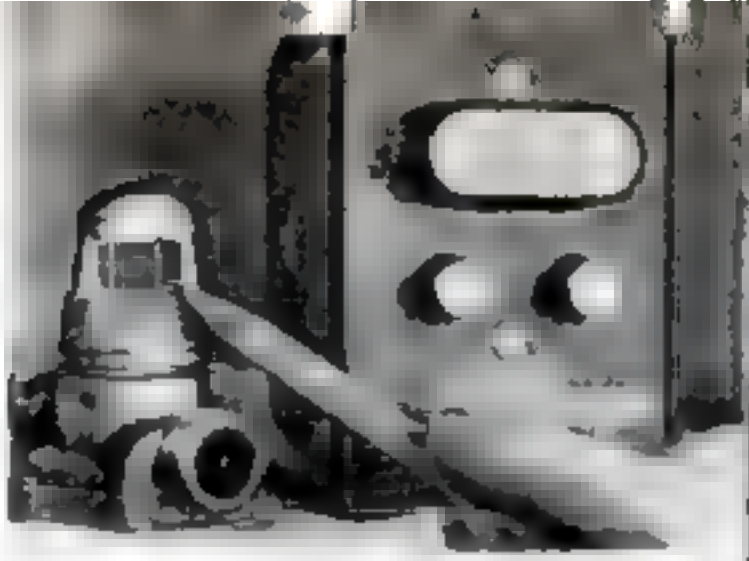
Wheel-type tractor. All airborne motor equipment burns gasoline, so that it can share the planes' fuel supply

A new carryall scraper for the flying engineers. It levels ground for runways, hauls away earth

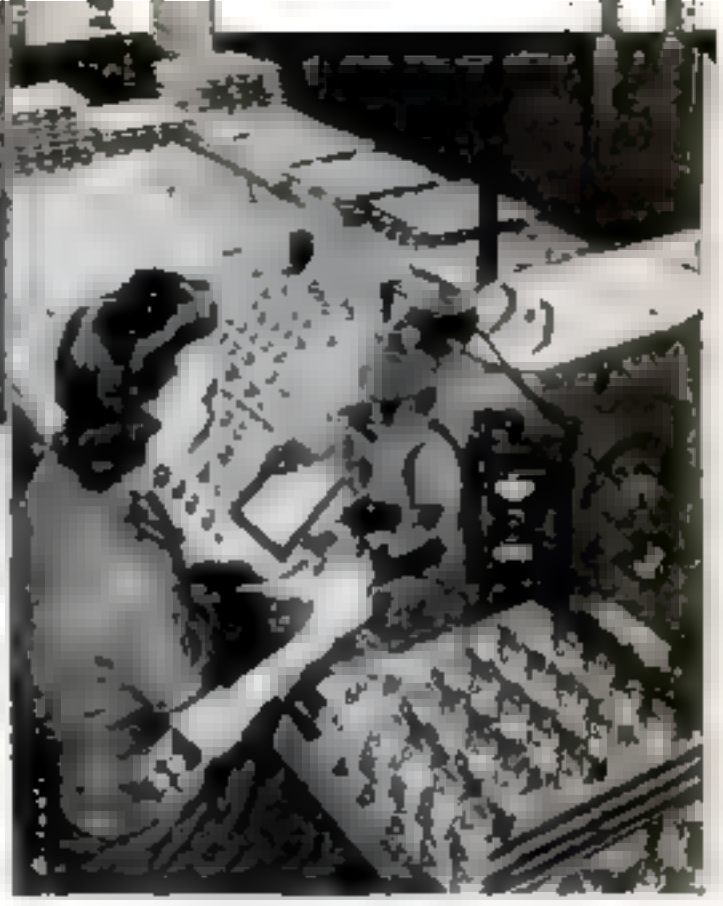


Another miniature machine is this compact air compressor, which provides pressure for pneumatic tools





Mere heat can't set off this fire detector, but open flames destroy the filaments indicated by the pencil to close an electric alarm circuit



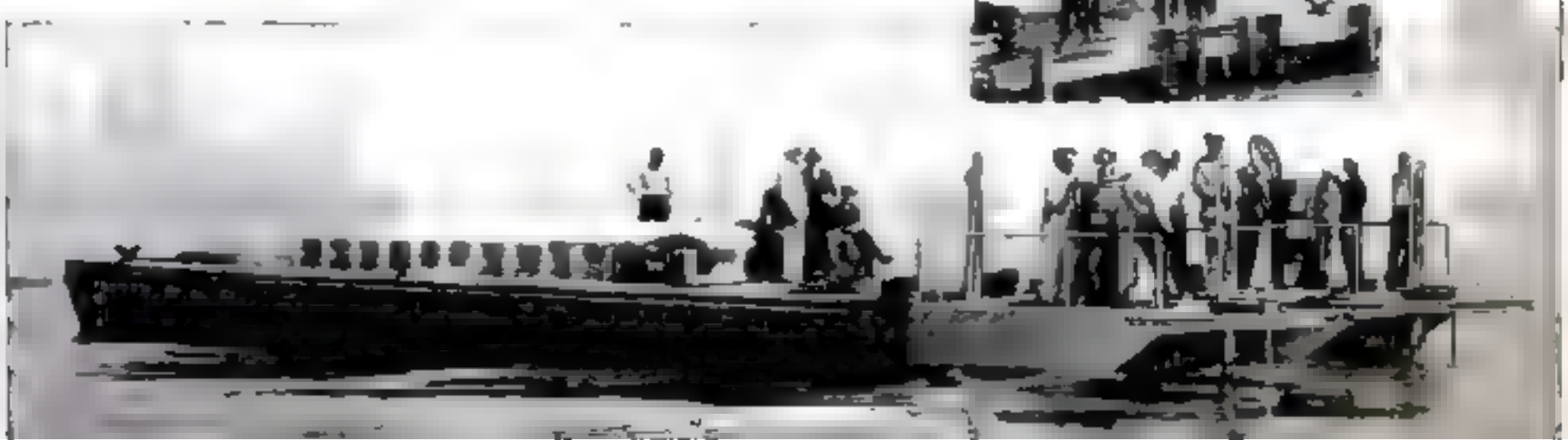
FLAME DETECTORS guard American planes, ships and other war equipment from fires started by enemy action or by operating conditions. One type, manufactured by Walter Kidde & Co., New York, and designed for use beside hot-running engines and in other spots where an ordinary thermostat would not serve, reacts only to the actual presence of flame. Two organic filaments, indicated by the pencil above, hold an electric circuit open. Disintegrating in flame, they close the circuit to give warning of fire. More conventional fire-detecting devices use thermostats with bimetallic disks of the type that serve in peacetime to control the temperature in electric irons.

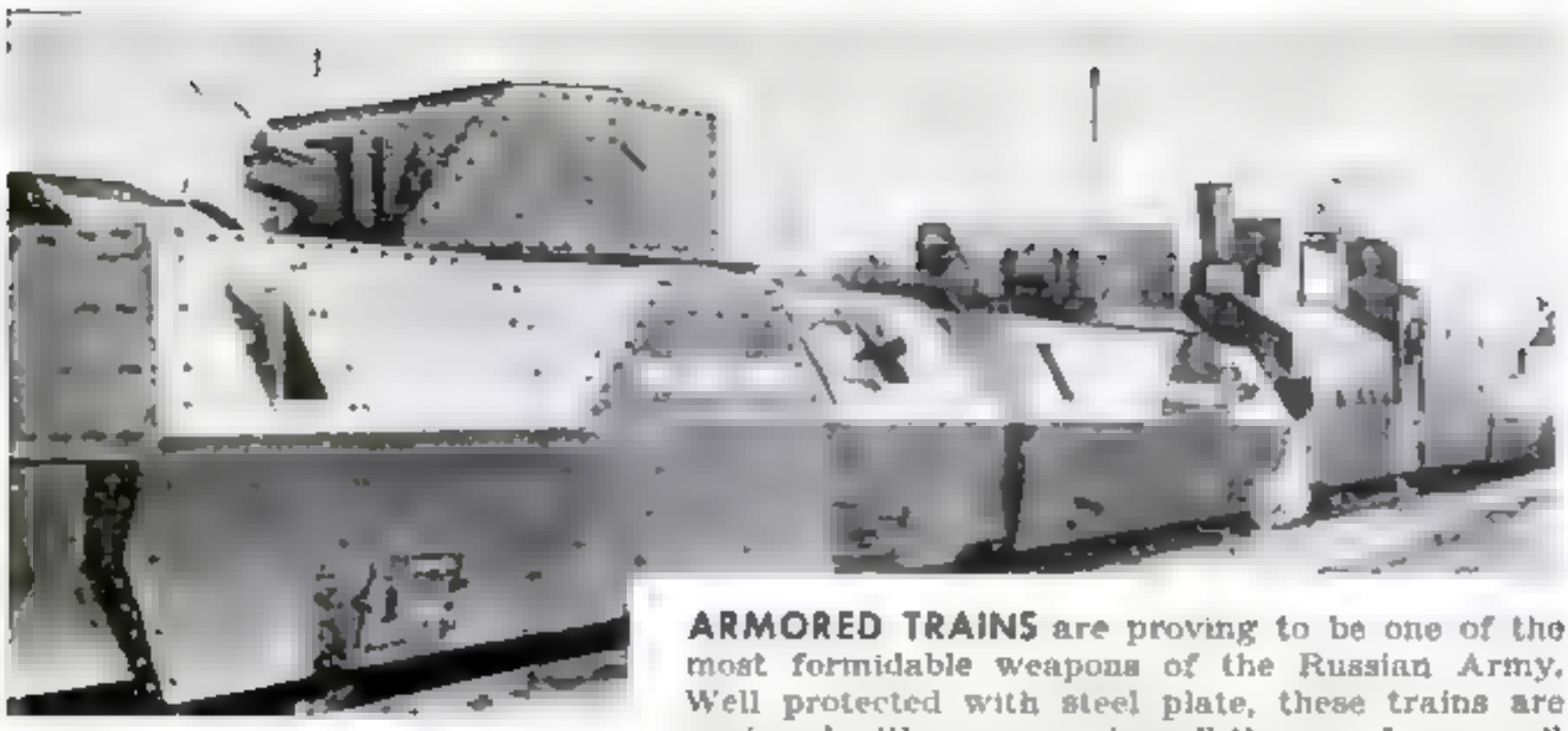
Here a Westinghouse worker spot-welds bases onto thermostats of more conventional type, like the ones employed in electric irons

WELDERS' GLASSES developed by the American Optical Company are providing better vision and so speeding up production of war materials. Special absorptive lenses enable the wearer to see the welding rod and the molten area clearly through the cloudy yellow flames produced by burning sodium vapors. The glasses also protect the eyes by absorbing harmful invisible rays. According to Dr. E. D Tillyer, research director of the company, the new glass contains didymium, a rare metal.

"SEA MULES." Floating tractor units to propel barges, scows, and other flat-bottom boats are now in production by the Chrysler Corporation. When attached to a barge, one of these oversize outboard motors forms a rigid structure with the rest of the craft and can move it at a speed adequate for most purposes. For increased power, two tractors can be attached to the same boat as shown in the photograph below. About 20 feet long and six feet wide, each power unit can be operated by one man; it costs only one twentieth as much to build as an average tug, and is much more economical to operate. Designed for use in shallow waters and where tugs are unobtainable, it is suitable for any kind of marine work except in heavy seas.

At the right, a "sea mule" is being lowered into the water for attachment to a barge. Below, two of the units propel a heavy load

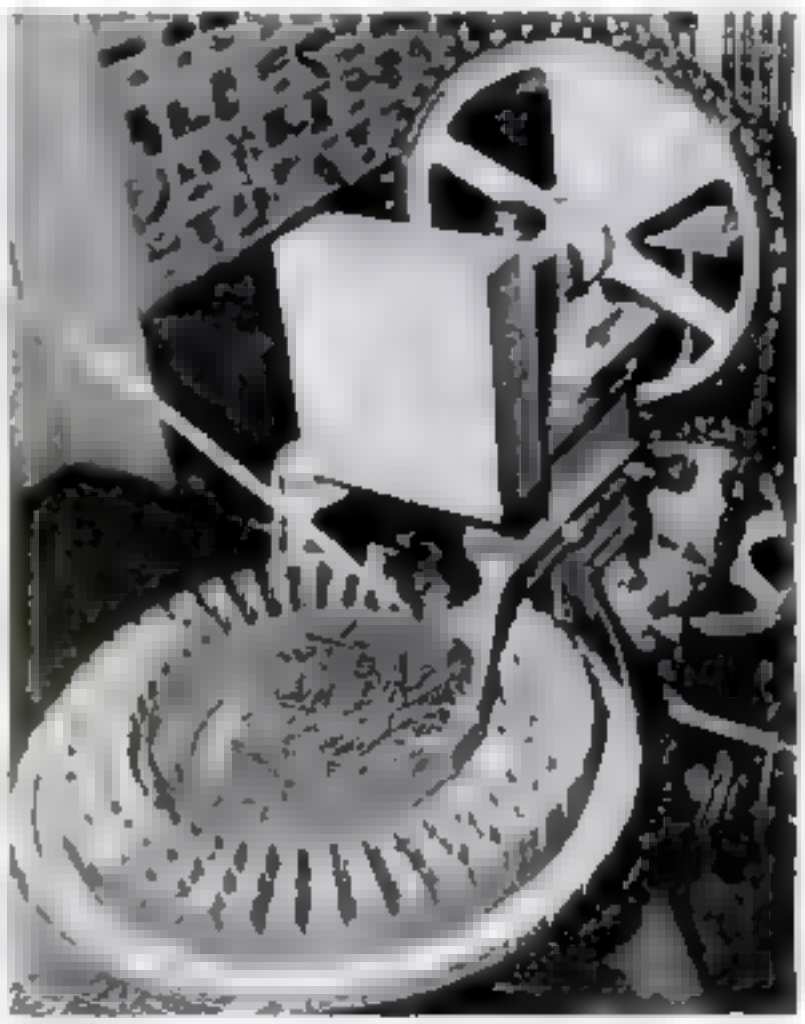




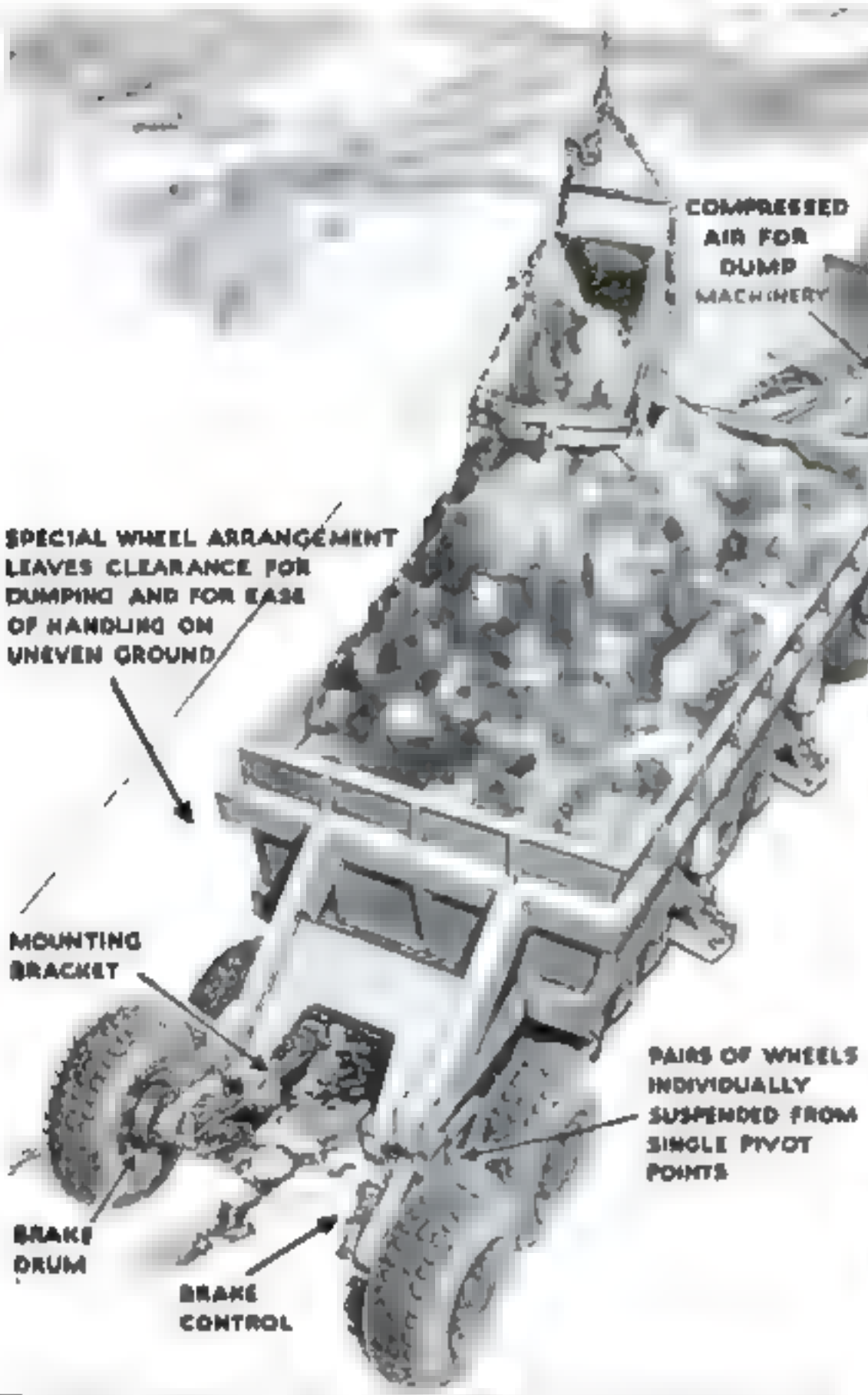
ARMORED TRAINS are proving to be one of the most formidable weapons of the Russian Army. Well protected with steel plate, these trains are equipped with guns ranging all the way from small machine guns to light artillery pieces. Ingenious tactics have made it possible to bring the full fire power of a train to bear on the enemy. The basic maneuver is for a unit of Russian infantry to engage an enemy infantry unit, and then to retreat toward hidden railroad tracks, luring the enemy after it. At a predetermined moment, the Russian infantry suddenly flees from the scene of action, leaving the enemy completely exposed, at point-blank range, to the fire of the train, which has made a quick surprise dash into the fight.

SUBWAY SPECTACLES, in which battery-powered bulbs are set in the eye frames, make it possible for readers to provide their own light in dim-outs. Developed by Dr. Maxwell Miller, a New York optometrist, the glasses can be used in a darkened room without disturbance to other occupants.

SETTING CROOKED NAILS STRAIGHT is being done by a machine invented by George D. Hulbert, a mechanic at a Los Angeles movie studio. Principal feature of the straightener is a circular metal table which contains 44 notches shaped like wedges. As the table slowly revolves, the operator drops nails of any size into these notches. As each slot passes a given point, indicated by the arrow in the photograph, a heavy hammer, shaped to fit the grooves, comes down on the nail and straightens it out. At another point in the turntable's circuit, an ejector drops the straightened nail into a bucket. Nails are hand-fed to the machine from a metal pan in the center of the revolving table. A 25-hp. motor drives the one-ton machine, which is capable of straightening as many as 31,000 nails a day. After the nails leave the straightener they are put into another machine which rapidly stirs them around so as to loosen any foreign matter clinging to their surfaces, and then brushes them vigorously until all dirt and rust has been removed.

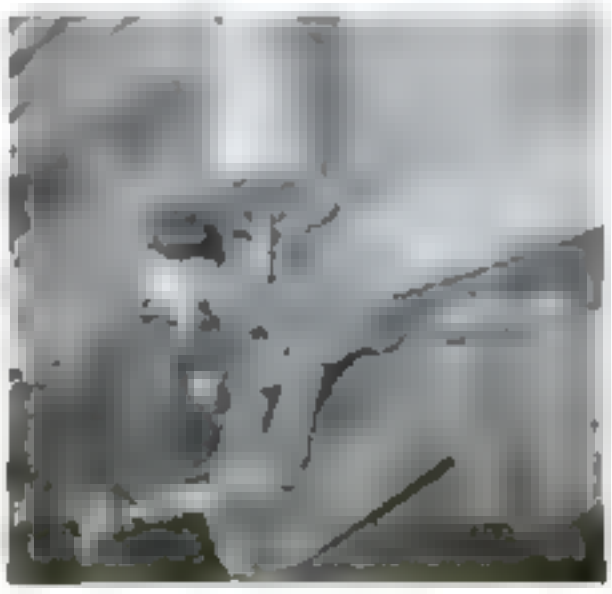


Trailer Truck Moves Muck in 80-Ton Loads

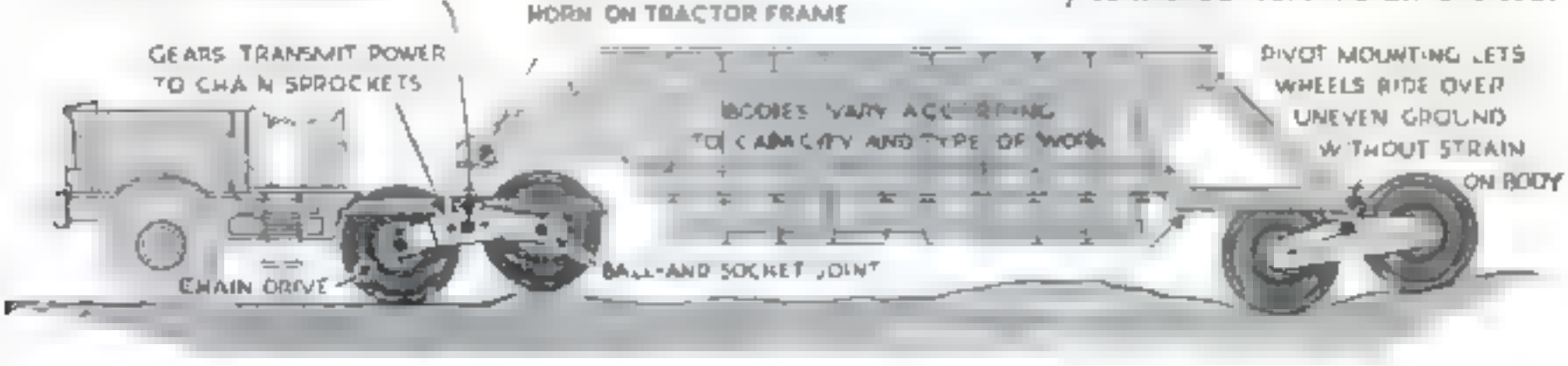


EIGHTY tons of dirt and rock can be carried over rough ground and highways at speeds from two to 40 miles an hour in this gigantic "muck mover" built by Six Wheels, Inc., of Los Angeles. A 225-hp. engine pulls the 11-ton trailer, which is 51 feet long and stands 10 feet high. The walking beams illustrated below reduce road shocks and insure full traction for all wheels.

A steel shield that runs from the front wheels to the transmission protects the engine in rocky areas



Loads are dropped through hydraulically operated doors individually controlled from the driver's seat



BROTHERS UNDER THE SKIN: The familiar landbound jeep and its seagoing counterpart, the Army's new Model GPA. The amphibian is essentially a specially equipped jeep with a steel hull built around it. The wheels operate in recesses

This Jeep

SECRETLY DEVELOPED ARMY AMPHIBIAN SCOUTS ASHORE OR AFLOAT . . . ALREADY IN ACTION AGAINST THE ENEMY

Photographs by WILLIAM W. MORRIS

NEWEST and most versatile member of the world-famous Jeep family, the U.S Army's ¼-ton amphibian (Model GPA) has now gone into action with U. S. forces

This seagoing jeep operates on either land or water, and can pass from one medium to the other with a single minor adjustment by the driver, during which the car doesn't have to stop. Its possibilities as a reconnaissance vehicle are startling. With it an advance patrol can creep up back roads to a river, scout along the shore, cross at any point to investigate the enemy's territory It can race back with its information about as fast as any other jeep—upwards of 60 miles an hour on good roads. Twenty of them can ferry 100 fully armed men across water to strike the enemy from the rear.

Here the 'Aqua Cheetah' crawling up the bank after crossing a river pauses while four men of its crew jump ashore to cover the landing Note the overhang of the hull at bow and stern, which gives the car an over all length of about 182 inches as compared with a wheelbase of 84 inches. The bow is blunt and slightly rounded, giving it the look of a sea sled. Like a regular jeep it has four wheel drive

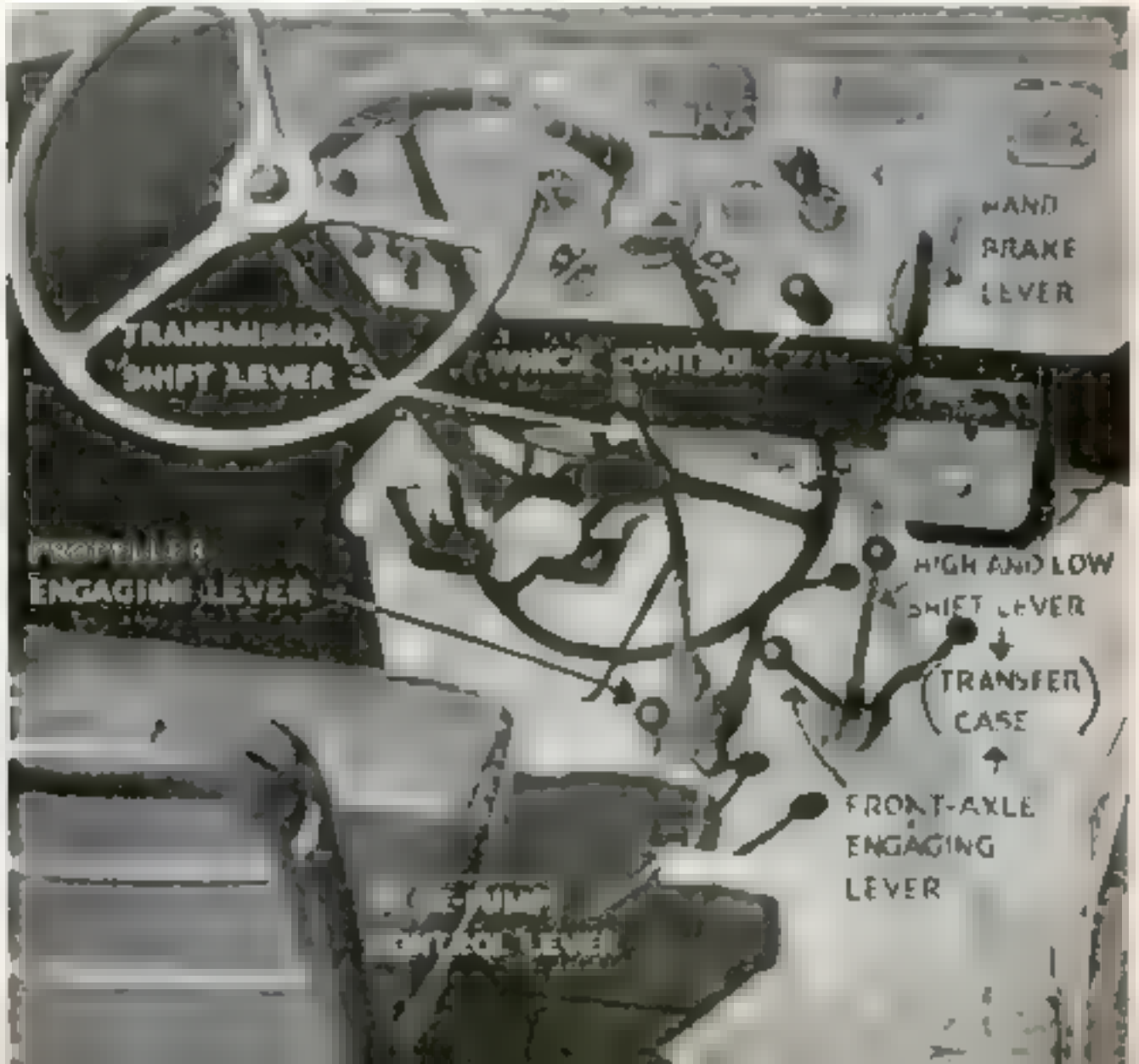
Can Swim

Hitting the water like a shoot-the-chutes car the jeep keeps right on going. In the water it is driven by a propeller and steered by a rudder controlled by the steering wheel. Weighing approximately 3,400 pounds, it is powered by a four-cylinder 60-horsepower engine and can carry a payload of something over 800 pounds in addition to its own equipment. For rough water going a hinged surf shield can be placed in front of the forward deck. Cooling ducts and ventilators are adjustable for water operation

SHIFT PLATE

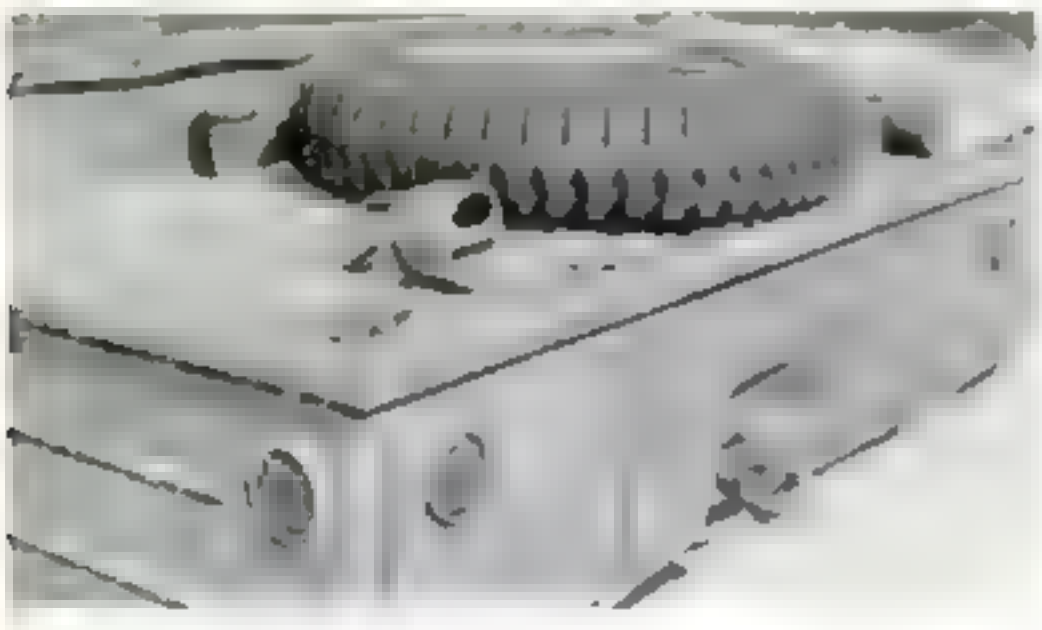
PROPELLER PLATE

Instrument panel and controls are like those of an ordinary jeep, except for shift levers for propeller and bilge pump



Operating on dry land above, the amphibian is used like its brother. Either two or four-wheel drive may be employed. On the front deck are lights for ordinary and blackout driving, and a power winch. The latter is used, as shown at the left, for pulling out of mud or up a steep, slippery lake or river bank

The stern deck carries a spare tire and the tail and stop lights. Filler pipe for gasoline tank comes up just behind the rear-seat back. All seat cushions are removable and can be used as life preservers, as seen at the right, if the car gets stuck in the middle of a stream or if enemy fire makes it necessary to abandon ship far out from the shore



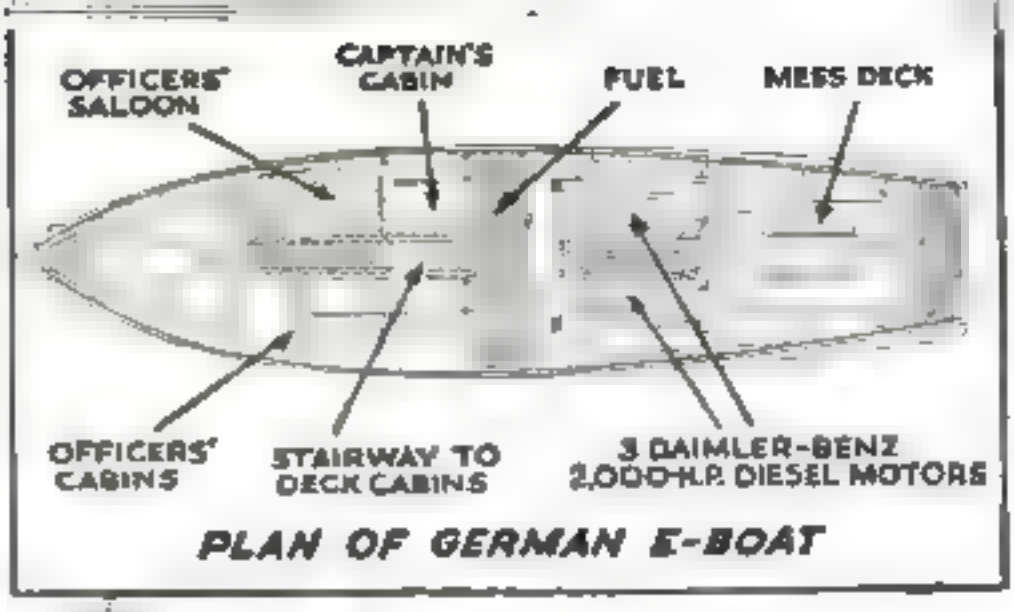
An officer's field coat issued by the U. S. Army Quartermaster Corps has so many novel features that it can do almost everything for a soldier but cook his breakfast. Shown at right is the detachable hood that can be buttoned on over the collar. When the drawstring is pulled tight, only a small part of the officer's face is left exposed to the weather

FIELD COAT DOUBLES AS BED AND SHELTER

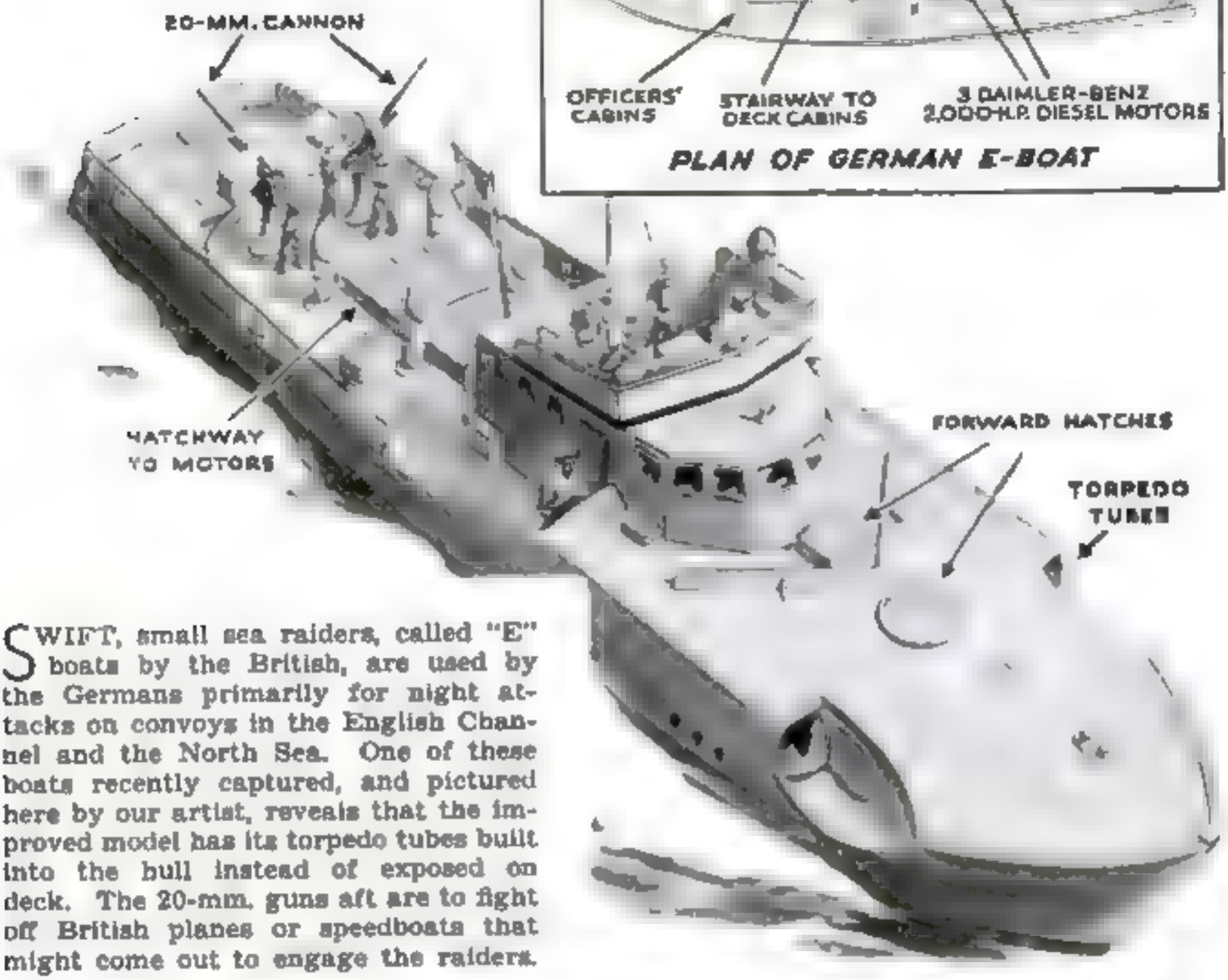
Another innovation provides for the front skirts to be buttoned back to allow maximum freedom of movement when the wearer is marching over rough terrain. Most novel feature, however, is the cantle piece at the rear of the coat. In addition to keeping out wind and rain, the pleat, when unbuttoned, makes it possible for the officer to string up the garment's poplin shell as a one-man shelter, using the wool liner as a blanket

Made of wind-resistant poplin, the coat has a complete knitted cloth-wool liner (above) the pockets and lapels of which are trimmed with satin. When detached, the liner can be worn as a light topcoat or used as a blanket or mattress. Fully assembled, the field coat is said to be much warmer than the ordinary overcoat

High-Speed Boats Make Night Raids on Allied Convoys



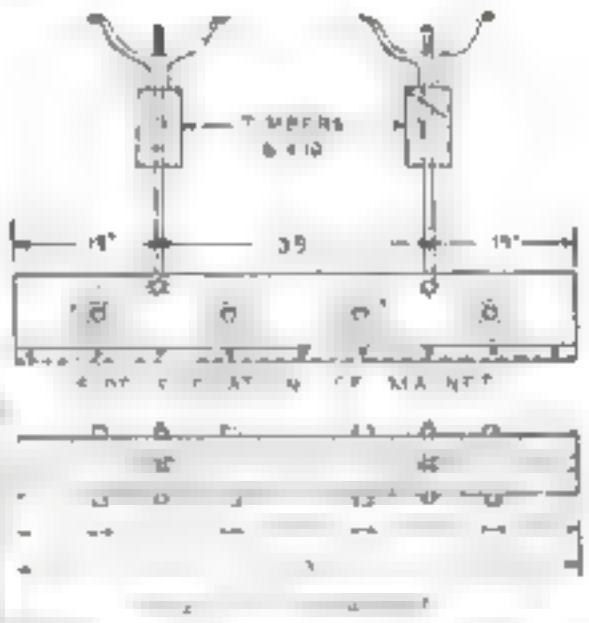
PLAN OF GERMAN E-BOAT

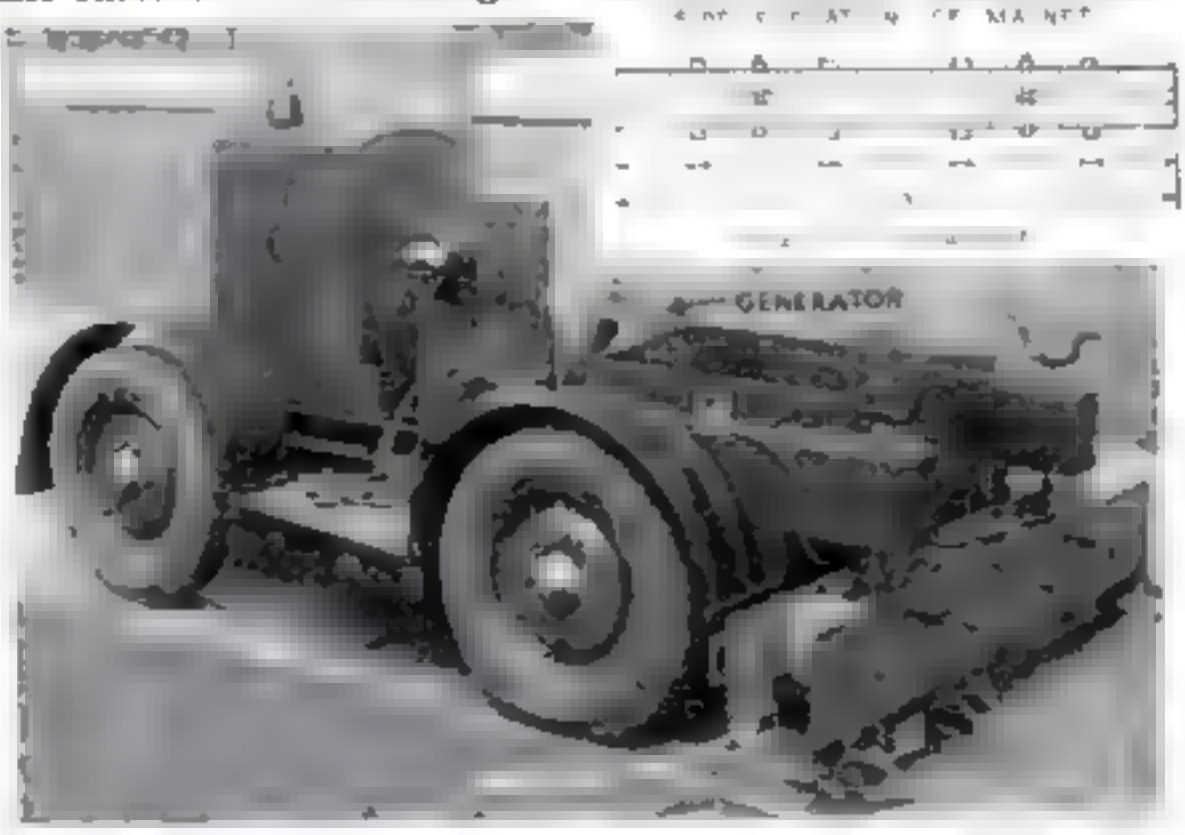


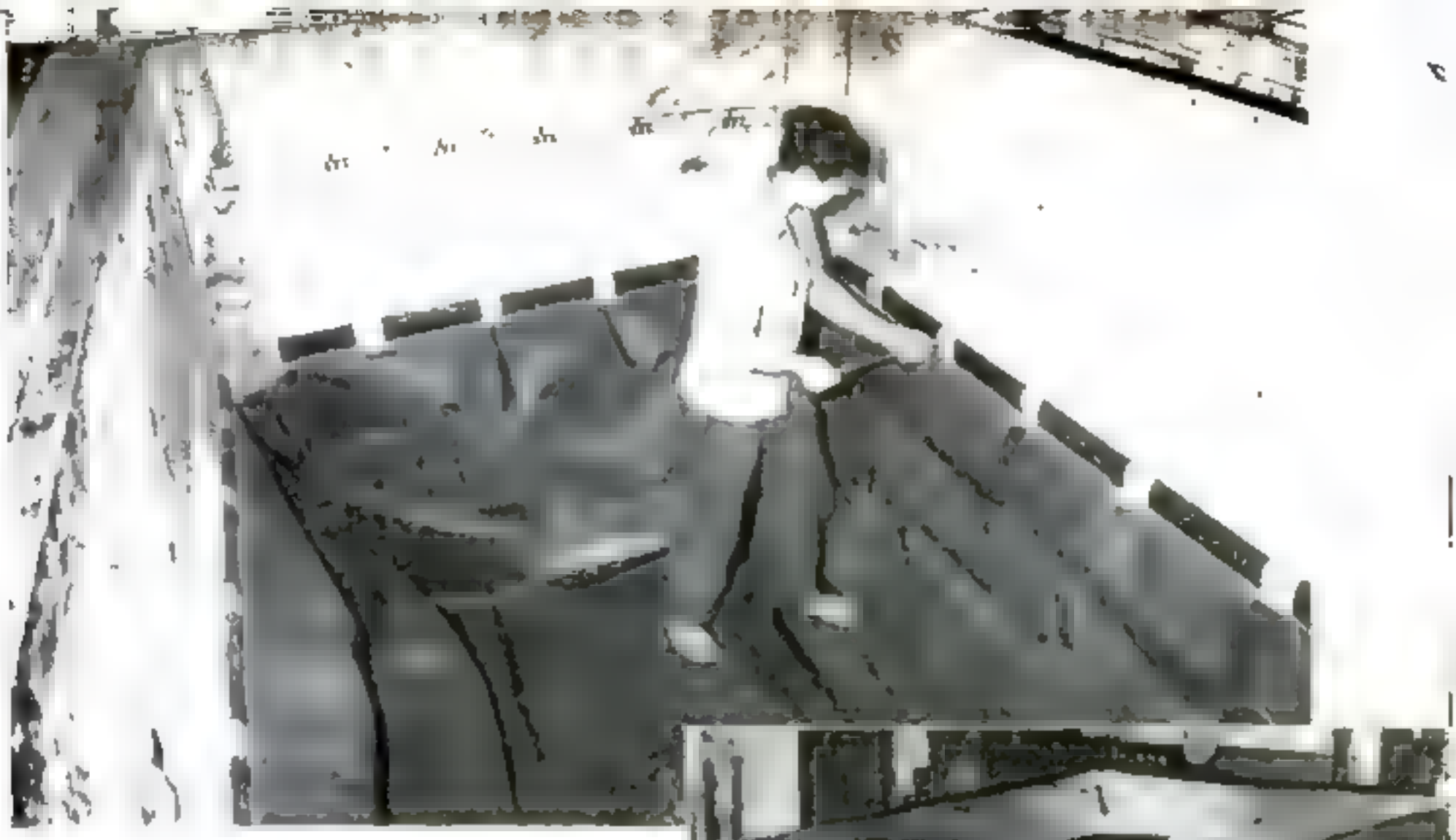
SWIFT, small sea raiders, called "E" boats by the British, are used by the Germans primarily for night attacks on convoys in the English Channel and the North Sea. One of these boats recently captured, and pictured here by our artist, reveals that the improved model has its torpedo tubes built into the hull instead of exposed on deck. The 20-mm. guns aft are to fight off British planes or speedboats that might come out to engage the raiders.

"Nail Picker" Saves Tires

A MAGNETIC "nail picker," designed to protect rubber tires and save scrap metal, roams the streets of the Brooklyn Navy Yard at a speed of about five miles an hour, snapping up any stray bit of metal debris that comes within its range Converted from an old World's Fair sightseeing tractor and trailer, the unit carries an electromagnet on adjustable hangers at the rear of the trailer. A 220-volt gasoline-driven generator of 2.5-kilowatt capacity energizes the magnet, which has four coils, each wound with 75 pounds of wire, and a copper sheeting that covers their lower surfaces. When the picker has collected enough scrap, it is halted and the magnet's current turned off to let the debris fall from the copper sheeting into a pile. The unit is pulled forward a few feet and the metal is shoveled into a bin between the rear wheels of the trailer.







One of the new thiokol fuel tanks is installed in a bulkhead of a box car for purposes of experiment. The average box car can carry six of these rubber "cells," one of which is shown at the right. Once the bulkhead is built, the synthetic rubber tank can be quickly put into place

Rubber Tanks for Oil Tested in Box Cars

AS REPORTED in an earlier issue of this magazine (P S M., Oct. '42, p. 66) synthetic-rubber fuel tanks that can be installed on ordinary railroad box cars, in wooden barges, or on trucks, offer a solution for the critical oil-transportation problem. Developed by the Glenn Martin Company, and made of a synthetic called thiokol, the rubber tanks, which are resistant to oil, are built in dimensions of about seven by six by six feet and are supported by bulkheads. When not in use, they can be easily dismantled, rolled up into compact packages, and expressed back to the original shipping point—leaving the box car or truck free to carry freight on the return trip.

Oil from a truck is pumped into one of the thiokol tanks aboard a box car. Engineers also plan to use tanks on wooden barges

The rubber tanks are tested in trial bulkheads before leaving the plant of the U. S. Rubber Co., where they are made under patents of the Glenn Martin Co., developer of the new synthetic

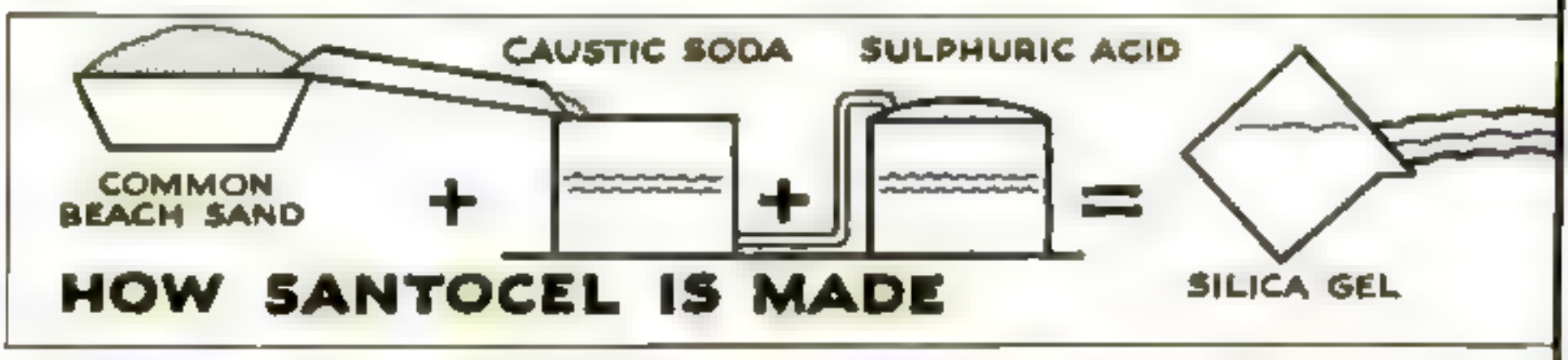
Skeleton Sand Powder

Here Santocel shows itself to be about 1.7 times less conductive than cork. Capable of being produced in unlimited quantities, Santocel promises to have widespread use in homes, trains, and cars

Held to the light, a lump of Santocel, known chemically as silica aerogel, proves to be translucent

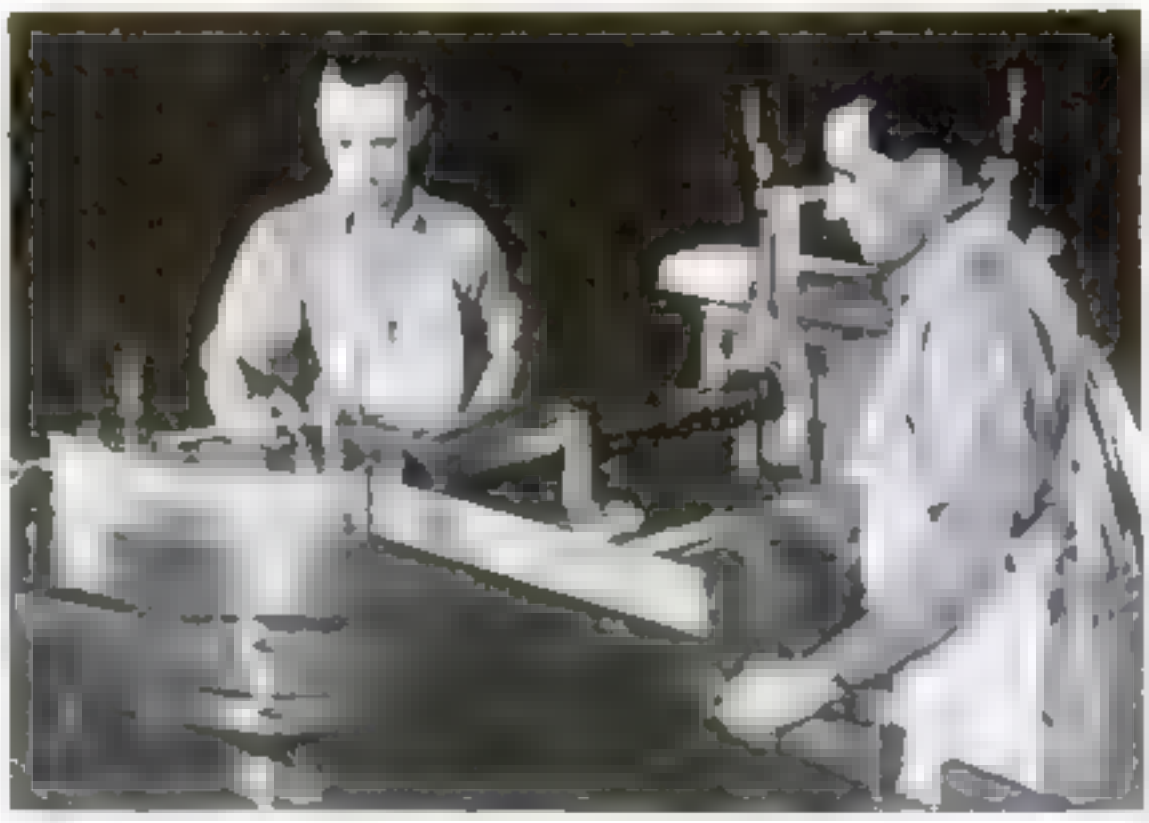
MERELY by soaking common beach sand in caustic soda, adding sulphuric acid, and heating this mixture into a fluffy white skeleton powder known commercially as Santocel, industrial chemists have found a means of producing in unlimited quantities a heat insulator nearly twice as effective as any other known substance.

With the exception of a vacuum, the best barrier to heat is immobile air. Such immobility, however, is possible only in theory, so the next best thing an insulator can do is



HOW SANTOCEL IS MADE

SHAPING METAL PARTS by causing the metal to flow into its new forms is made possible by a machine developed by the Southern Engineering Co., of Los Angeles. Under air pressure of 1½ tons, a pusher block forces the material against a revolving die. At right, three straight pieces are shown being placed between the pusher and the movable die, whose shape they will take. This method is said to control internal stresses and to prevent wrinkling of the material. The machine can handle a wide variety of tough metals.

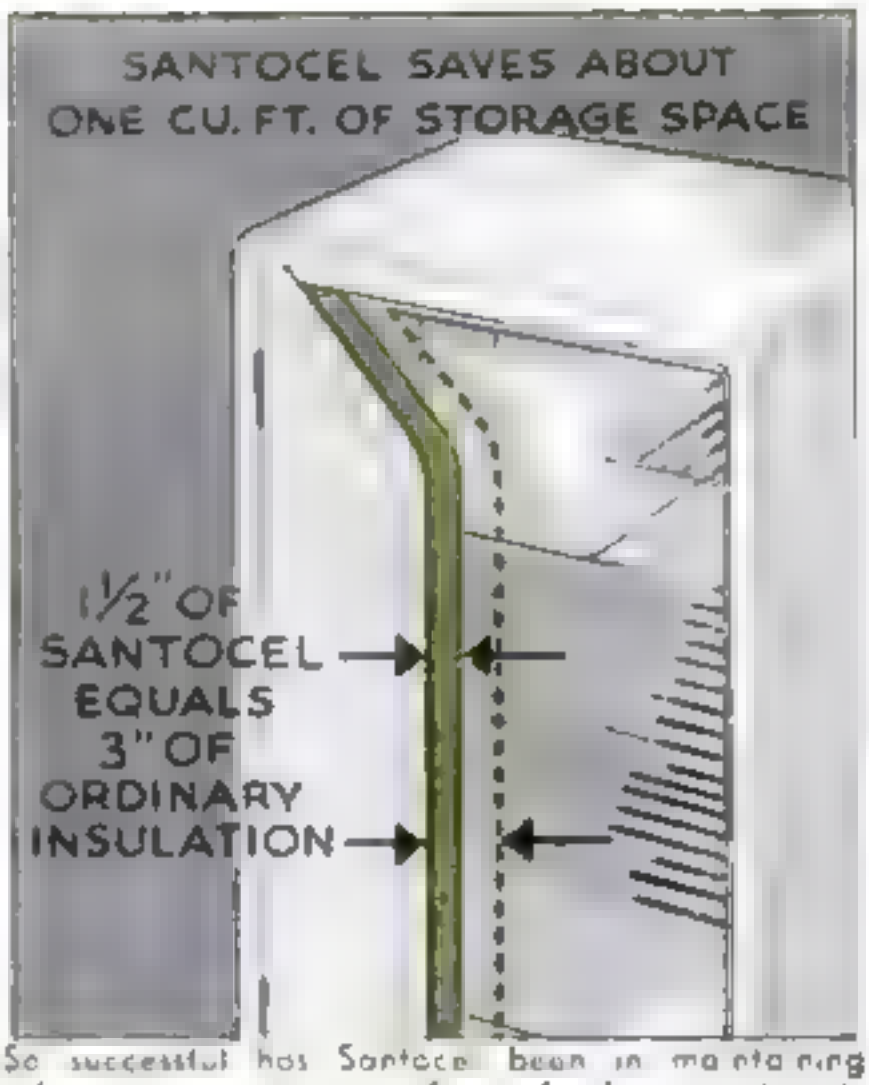


Tops All Heat Insulators

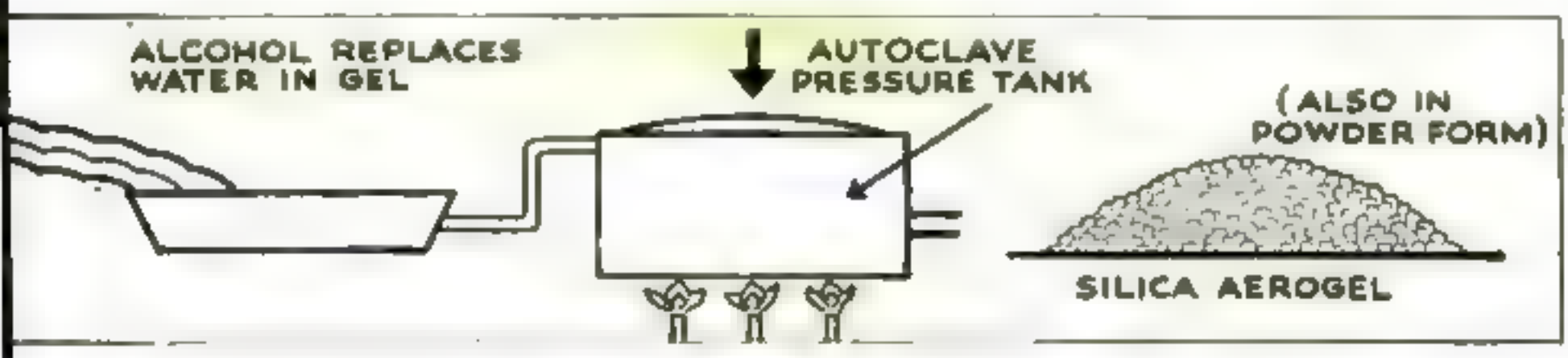
to keep air as quiet as possible—by trapping it in compartments so small that no "breeze" can gain headway. Cork and sawdust, for instance, are good insulators because their cellular structure is so minute that it leaves little room for air pockets. Yet the cells of these substances look like oversized balloons in comparison with those of Santocel, which are so small that they can be seen only under a high-powered electron microscope Because of this, the powder transmits about 1.7 times less heat than cork, and about three times less than most insulators.

Santocel has a high resistance to absorbing moisture vapor, which in insulators like mineral wool forms gaps to provide air pockets. Yet if soaked with water it will be spoiled. There is also a danger of its volatile material vaporizing at high temperatures.

At low temperatures, however, there are no strings to Santocel. It has proved extremely effective in maintaining subzero cold in frozen-food compartments and is now being tried out as a filler in the walls of home refrigerators. If successful, it will add a cubic foot of storage space to the average-sized refrigerator by reducing the thickness of insulation.



So successful has Santocel been in maintaining subzero temperatures in frozen-food compartments that it is now being tried out as a filler substance in the walls of home-sized refrigerators



A RAILROAD which, when completed, will be the third to cross the towering Andes, is now under construction between Argentina and Chile. The purpose of the line is to expand inter-South American trade and to eliminate the dangers of wartime shipping between the two coasts. Work is proceeding from both ends on the 550-mile line, which is presenting many difficulties. In one 190-mile span, the road required 30 bridges and 20 tunnels. At the border the line will cross the Andes at an elevation of 12,600 feet.

Putting More Speed and

TESTS ON MODELS IN HUGE TOWING BASIN SHOW HOW TO BUILD THE SUPERSHIPS OF TOMORROW

By BERNARD WOLFE
PHOTOS BY ROBERT F. SMITH

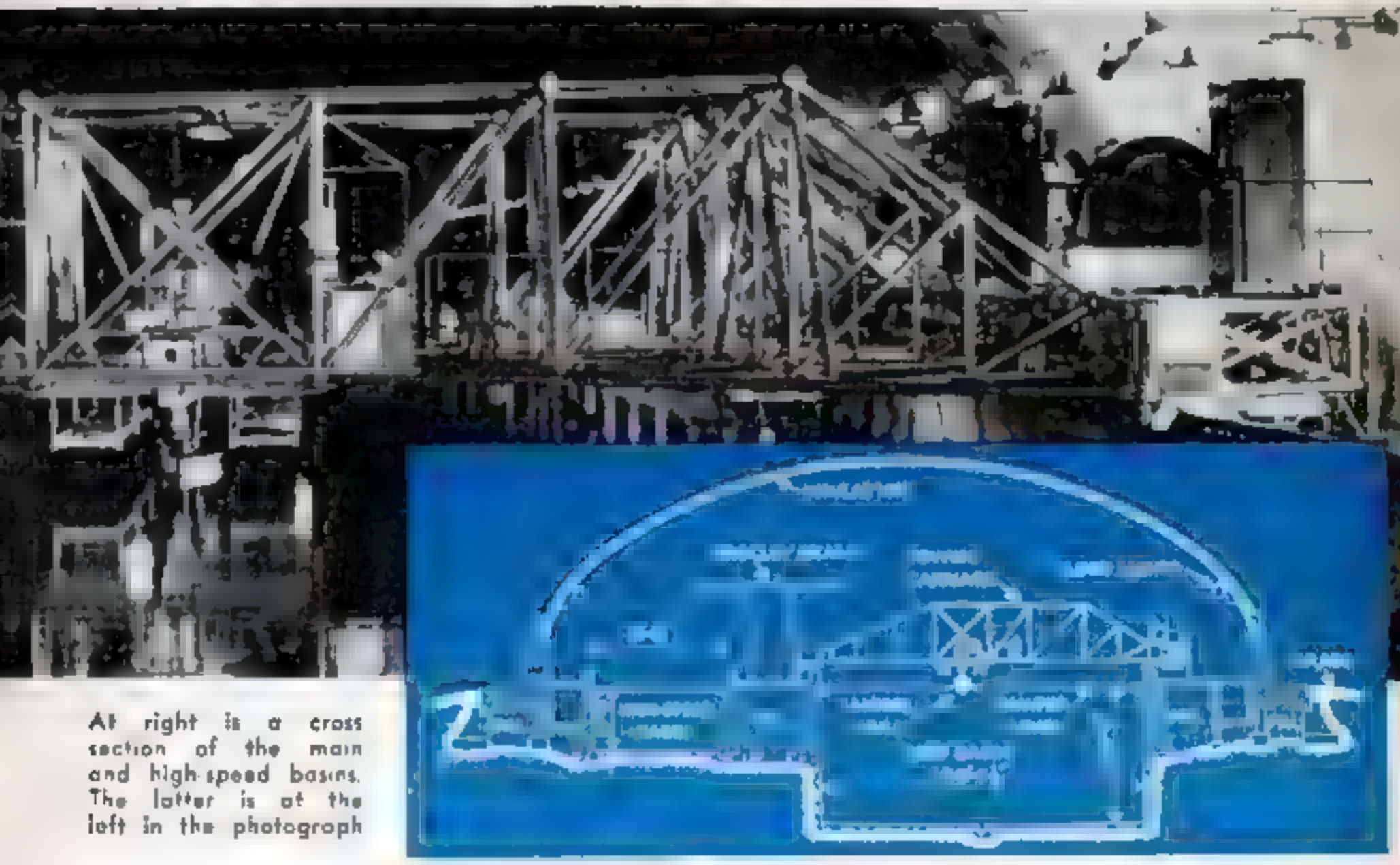
THE Navy's newest and most spectacular research plant, the David Taylor Model Basin at Carderock, Md., is today right in the thick of the war, going full blast on a host of specialized problems raised by actual combat experience. Lessons learned in battle are being translated into new and better designs for fighting ships and transports. They are leading to more speed and deadlier wallops that are already being felt by our enemies.

MODEL-BOAT BASIN. Scale models of fighting ships are towed by the bridgelike structure through this channel to show the Navy what its newest vessels will do when they join the fleet. The big towing carriage is mounted on rails and gets power from the overhead lines at left. Battleship models as long as 30 feet can be tried out here

Functioning also as trouble-shooter, the basin staff swings into action whenever an American ship reports its power system, maneuverability, structure, or general seaworthiness not up to muster. When they are not tackling some ticklish design job, these naval architects and engineers are hard at work improving submarine nets, devising underwater targets, or solving a thousand and one other problems that have cropped up during the war

HEART OF THE MODEL BASIN—THE TOWING POINT. Every factor that might interfere with smooth movement of this tiny point at the juncture of the towing bracket and link is controlled with all the Navy engineers' skill. Any side movement or speed irregularity will upset the calculations that will be multiplied enormously in a full-size ship. At right, operators read dynamometers on a model's motors

Power into Our New Navy



At right is a cross section of the main and high-speed basins. The latter is at the left in the photograph

at sea on all our far-flung fighting fronts

Many of the exacting tests are carried out with astonishingly precise wooden models of ships that will eventually slide down the ways. These models, ranging in length from eight to over 30 feet, are built on the premises from designs drawn in the plant's drafting rooms

Multiple lifts or layers cut from heavy planks are fastened together with wooden

MAKING A MODEL HULL

Planks are glued into blocks in a specially designed press (left foreground in the view at right) to make the hulls at Carderock. Then they are fed into the profiling machine shown in the left background and in the view below

Transverse bites are taken out of the blocks by rotary cutters in the profiling machine to rough-shape hulls, but precise truing of lines is done, as at right, by hand. Models conform to specifications within .01 inch

dowels and hot, waterproof, resin glue, then consolidated into rigid blocks in a glue press capable of exerting a pressure of 1,200,000 pounds. These blocks are fed into a model-profiling machine, where rotary cutters take transverse bites. Precise truing of hull lines follows by hand.

Once completed, a model is floated through a channel into a 1,330-foot testing-basin building that is the heart of the whole plant. The huge tunnel-like enclosure has a barrel-arch roof of reinforced concrete hinged at three places to allow for expansion or contraction.

Along one side runs a deep-water basin, big enough to accommodate models of the largest battleships; extending out from it, beyond a caisson, is a shallow basin for models of tugboats, river boats, and kindred vessels. Should the towing carriage on the deep-water basin need an added run to work up speed for special tests, the caisson can be removed, allowing the shallow channel to serve as a runway.

The shallow basin also connects with a U-shaped turning basin used to test the turning and maneuvering characteristics of a model. For this the towing carriage speeds up along the shallow basin on a straight run and releases the model, which is propelled around the bend under the guidance of its own rudder. The entire tunnel is plunged into darkness, and movie cameras on an elevated platform follow target lights to record the movements.

Finally, there is a high-speed basin where

models of motorboats, seaplanes, high-speed vessels, pontons, and friction planes are put through their paces. This channel, now 21 feet wide, 10 feet deep, and 1,168 feet long, will eventually be extended to about 2,400 feet. Its towing carriage is designed to hit a maximum speed of 30 knots.

These towing carriages are real engineering feats. The chief headache in setting up a model basin is to build all the parts influencing the towing point to such close tolerances, and then to control their warp and wear so painstakingly, that the towing motion will remain uniform throughout. Any side movement or speed irregularity will upset the results registered on sensitive dynamometers that measure resistance torque, and thrust, and what looks like an inconsequential discrepancy in the model may loom as an error of the first magnitude in a full-size vessel. For this reason, models built in the basin's shops conform to specifications within .01 inch, whereas a large-scale ship may deviate from design dimensions by as much as six inches.

Every factor that might conceivably interfere with the smooth running of the towing point is controlled with all the skill Navy engineers can muster. First of all, the reinforced concrete walls on which the

FITTING OUT THE HULL FOR TESTING

Though towing yields much data electric motors are installed (left) for additional tests. These motors are controlled by a rheostat set in the towing carriage

Weights are added to the hull to float it at the water line indicated by the mark on the bow and shifted for proper trim which is measured accurately with a level

Once completed the model is floated through a narrow channel into the testing basin building where it is fastened onto the towing carriage

carriage rails rest were carried down to bedrock. The tracks themselves are miracles of precision machining and track-laying skill. Vertical variation nowhere exceeds plus or minus .005 inch, nor is lateral variation any greater.

Fitted into position with microscopic and electrical checks, the tracks are fastened so securely that the vertical deflection in the top surface of any rail when a carriage wheel passes over or adjacent to a given point is never more than .001 inch. If you were riding on a railroad train over tracks of such precision, you would actually not be aware of movement, so smoothly would you be traveling

The Carderock rails were even laid to follow the curvature of the earth's surface so that the influence of gravity would remain constant. It took upwards of 15 months just to complete these runways, but in return for their pains Navy engineers got a towing point which, when the building has settled firmly, may yield dynamometer readings accurate to .01 pound.

The larger of two towing carriages spanning the deep-water basin is a weird mesh of silvery tubes, fantastic enough to give Buck Rogers an inferiority complex. Some of these pipes come together at 10-member spherical joints, and all enclose one vast connected space which is emptied of air and filled with nitrogen to prevent corrosion. The network itself is constructed in the form of an isosceles triangle, with its base running along the main rail and its apex resting on the steady rail.

The track system is virtually monorail, for the carriage's center of gravity is close to its base, and the greater burden of its weight—72,800 out of 85,400 pounds—rests on the main rail, supported by four flangeless driving wheels attached to the base girder. There are also four pairs of horizontal guide wheels which bear against opposite sides of the rail head and keep the vertical driving wheels from swerving. The carriage can be accelerated and decelerated with amazing smoothness and leveled off to uniform motion at speeds as low as .1 knot. The designers' goal was a speed that would show no variation greater than .01 knot under operating conditions.

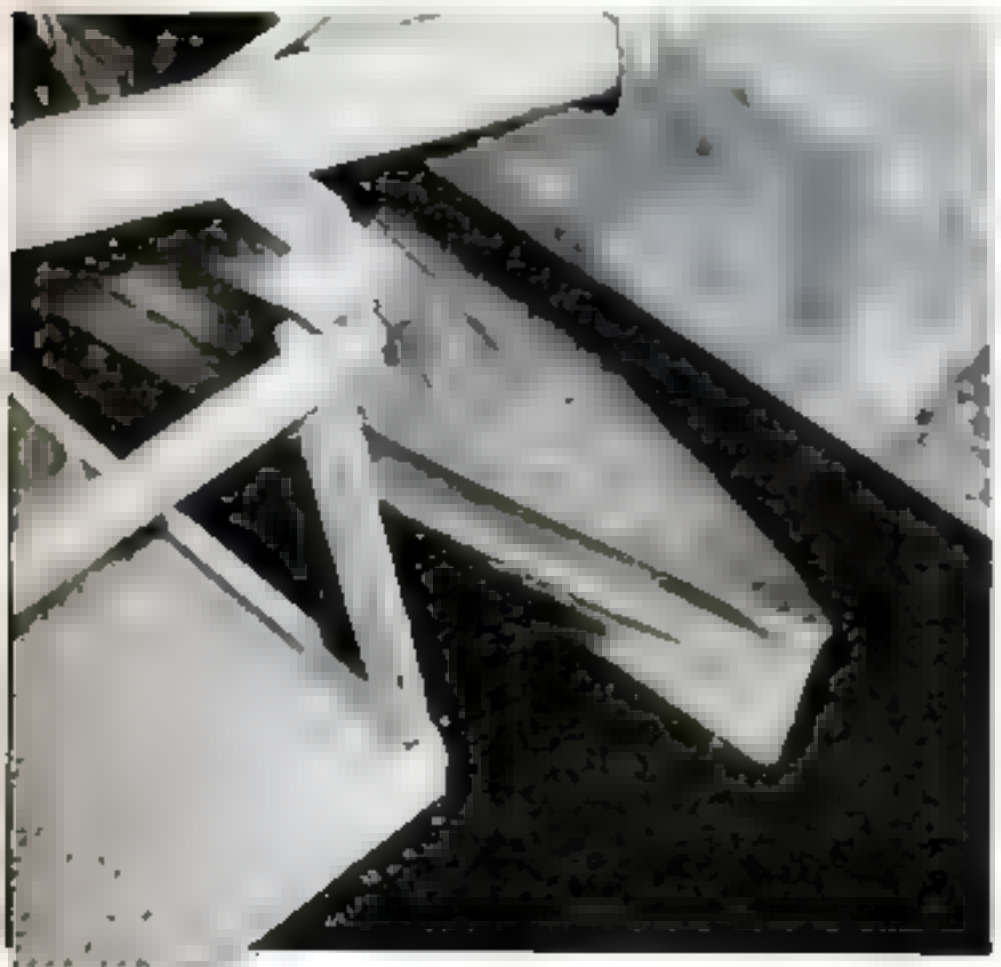
In operation, a model, sometimes weighing as much as 3,000 pounds, is fastened to a towing link and bracket hanging down from a towing dynamometer of the floating-frame weighing type. Starting at one end of the basin, the carriage gradually attains the speed required. As it is towed, the model develops its characteristic wave formation and induces a steady flow of water in contact with its wetted surface. Wave formations may be recorded for analysis by a stroboscopic camera, while resistance is registered on the dynamometer.

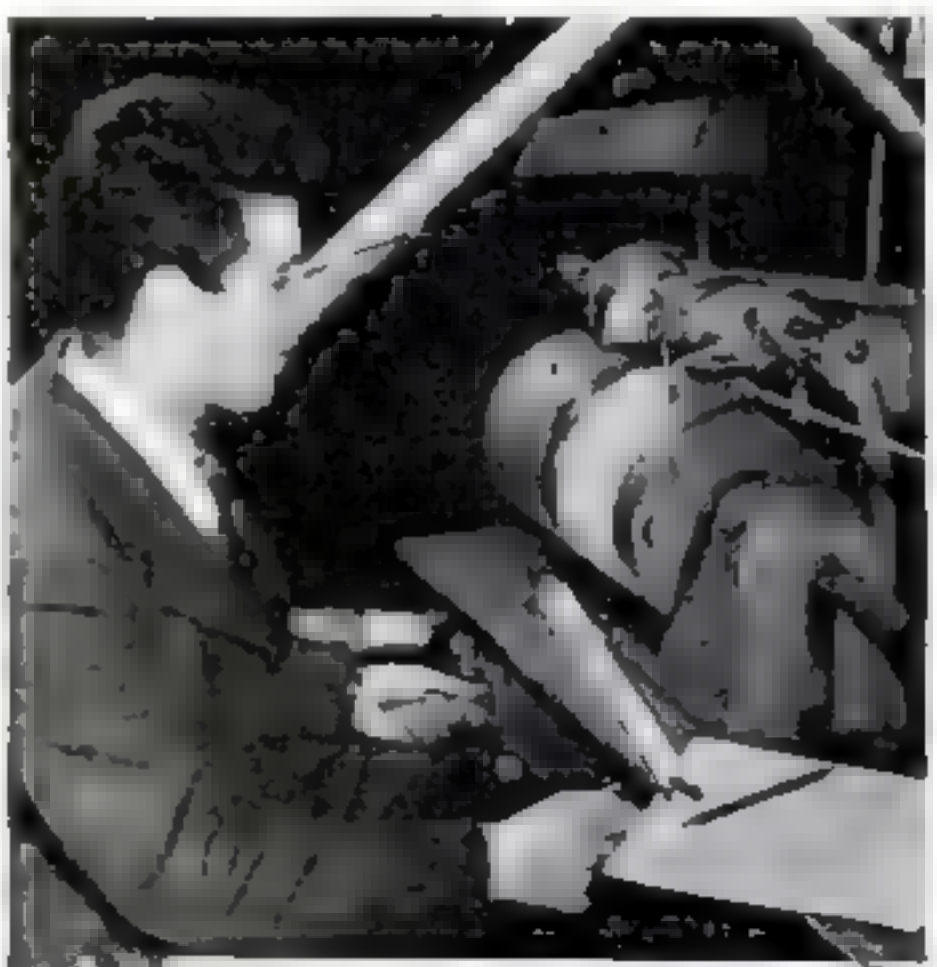
In determining the power required to drive a ship at a given speed, two types of resistance must be considered. Frictional resistance, induced between a hull's wetted surface and the passing water, accounts for most of the resistance at low speeds. But at higher speeds another type of resistance, called "residuary," due chiefly to waves produced at bow and stern, becomes extremely important. Carderock engineers, by subtracting frictional resistance from the total resistance registered on their dynamome-

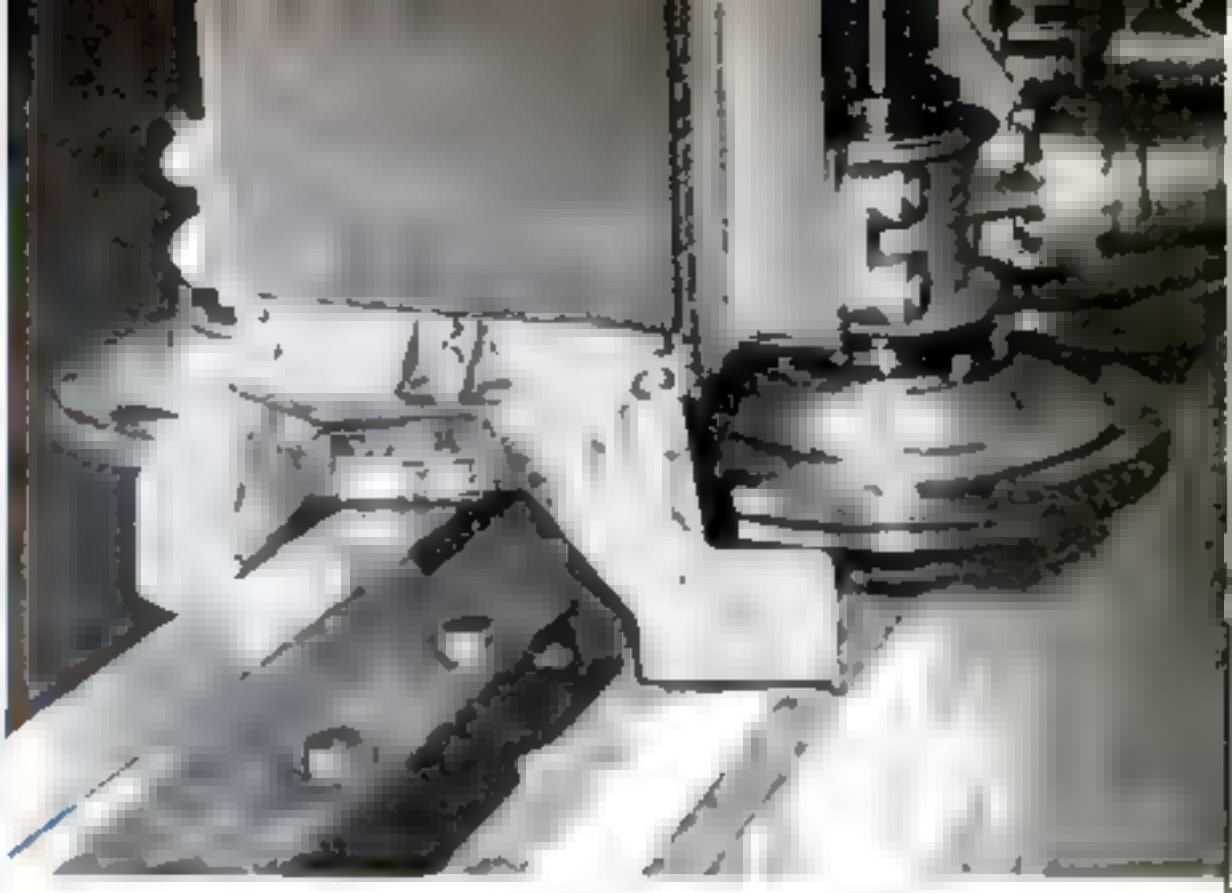
OBSERVING A HULL'S JOURNEY THROUGH THE BASIN

EDDIES. Characteristic wave formations such as these at the bow, develop while the model is towed. A stroboscopic camera photographs them for analysis

GRAPH. Seated on the carriage at a revolving drum, this operator watches dynamometer recordings of the resistances induced by hull's movement







TRACKS

Two pairs of horizontal guide wheels at each end of the carriage keep the vertical driving wheels from swerving on the main rail. Four driving wheels run on the main rail and two wheels run on the steady rail, as is shown at the left

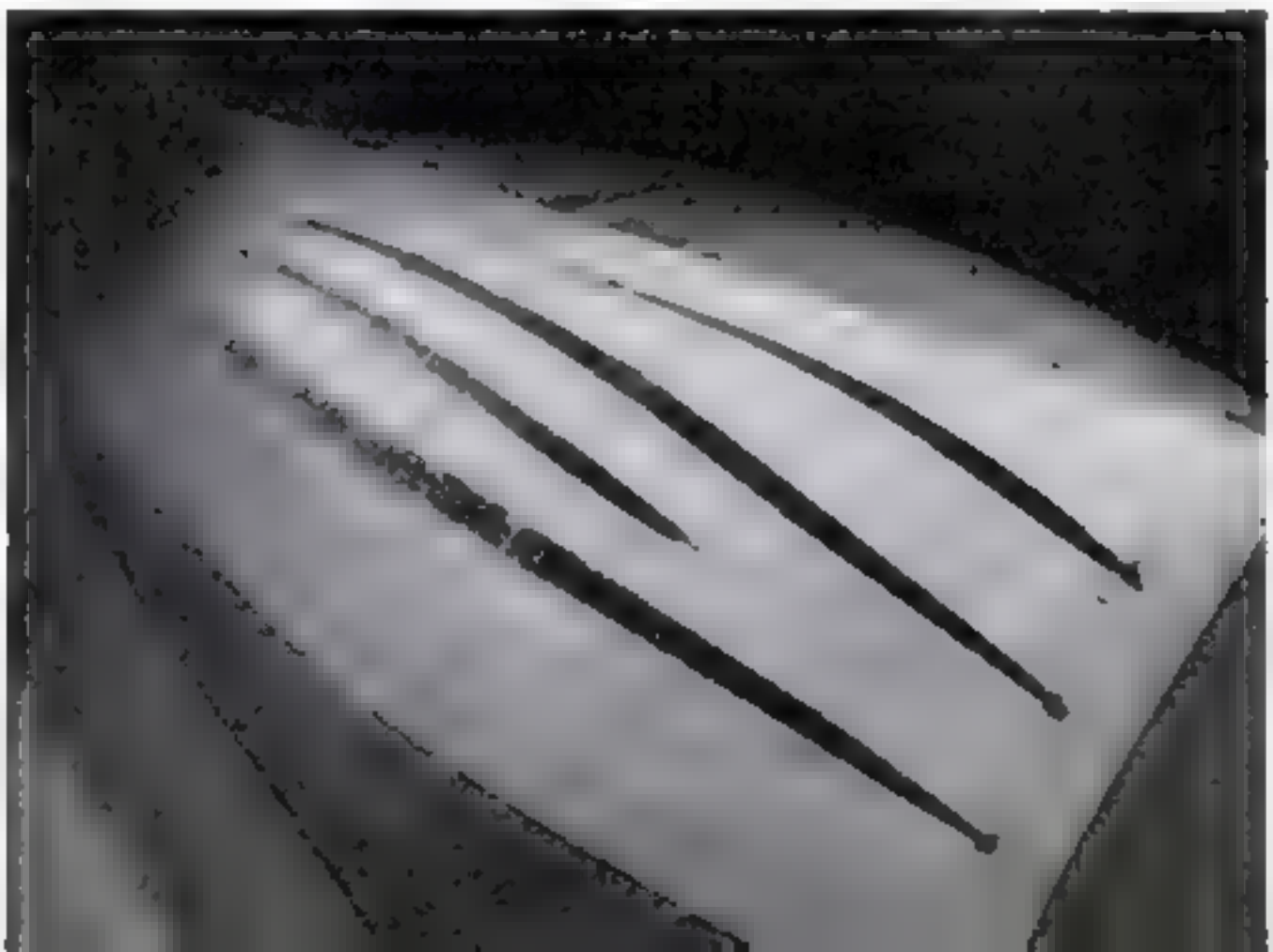
ters, arrive at the residuary resistance, which is markedly affected by the hull contours they are studying.

However, towing the bare hull will not yield all the essential data about a model—it must also be ascertained how resistance is increased by the drag of eddy currents around bilge keels, propeller-shaft supports, rudders, and other projections, as well as by the actions set up by the screws themselves. For this phase of the research, the model is fitted out with appendages, given further towing tests, and then finally rigged out for self-propulsion with electric motors and

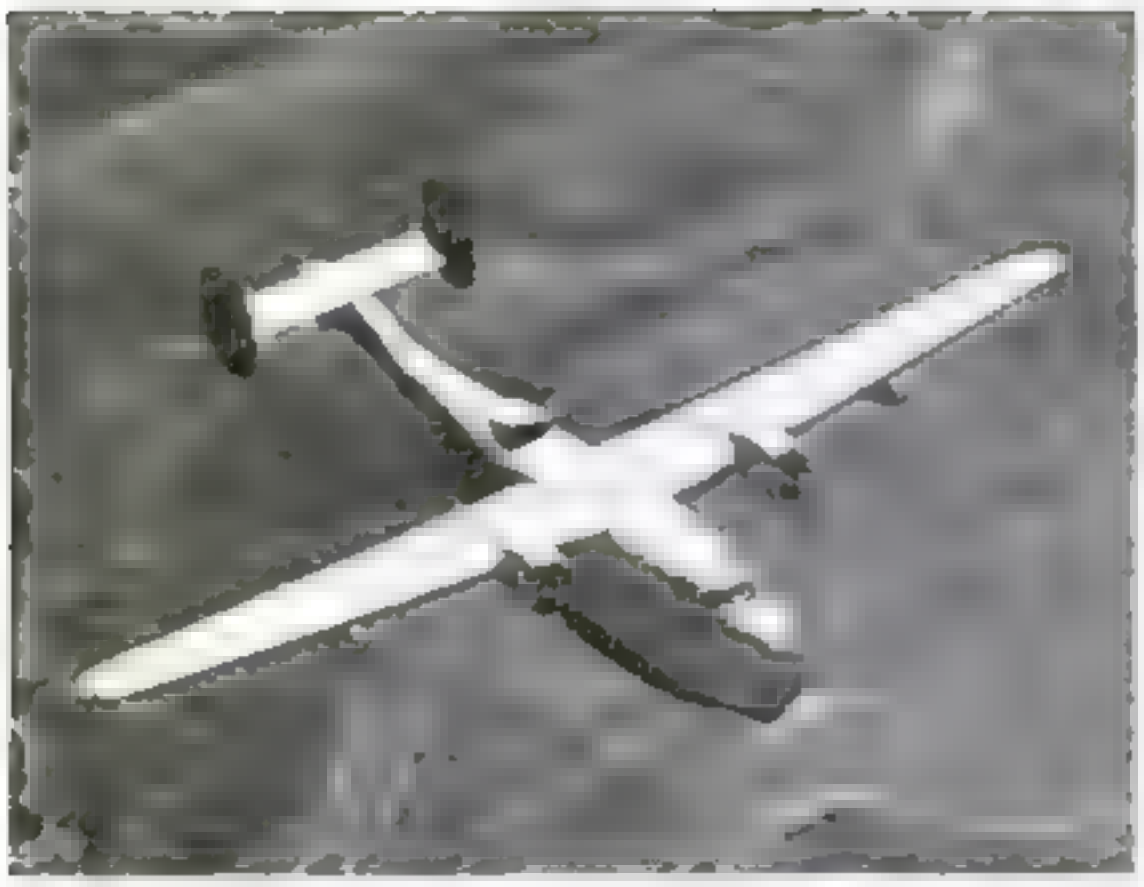
The speed of these motors, which also function as dynamometers to register torque and thrust, is controlled by a rheostat operated by the man at the carriage's recording mechanism. This operator's job is to bring about a balance between the model's speed and the speed of the carriage, so that the model will be entirely under its own propulsion during the registering period although it remains attached to the towing point. When this balance has been attained, two more operators, lying on platforms near the water's surface, take readings from the dynamometer scales on top of each motor.

GIVES VITAL SHIPBUILDING KNOWLEDGE

SULPHUR STREAKS. To establish the efficiency of hull forms, small holes are bored, and a solution of hydrogen sulphide gas is allowed to escape during the towing. Surface streaks follow the lines of flow

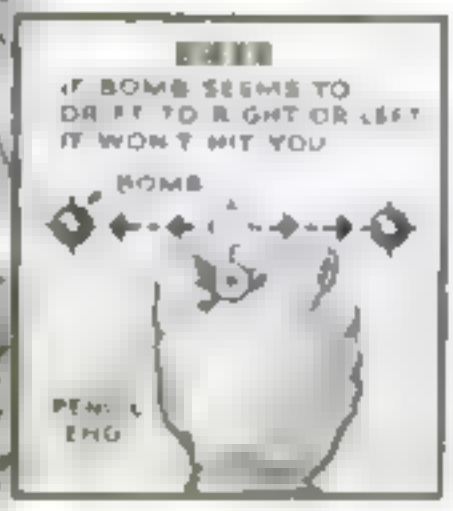


To round out their picture of new ship designs, Carderock experts engage in a whole series of supplementary studies. They have a 142-foot model basin in which they can test special forms, stability, launching, and unusual hydrodynamic problems. They are perfecting plans for a 60-foot circulating water channel for keeping a model stationary while they observe it through a glass window.



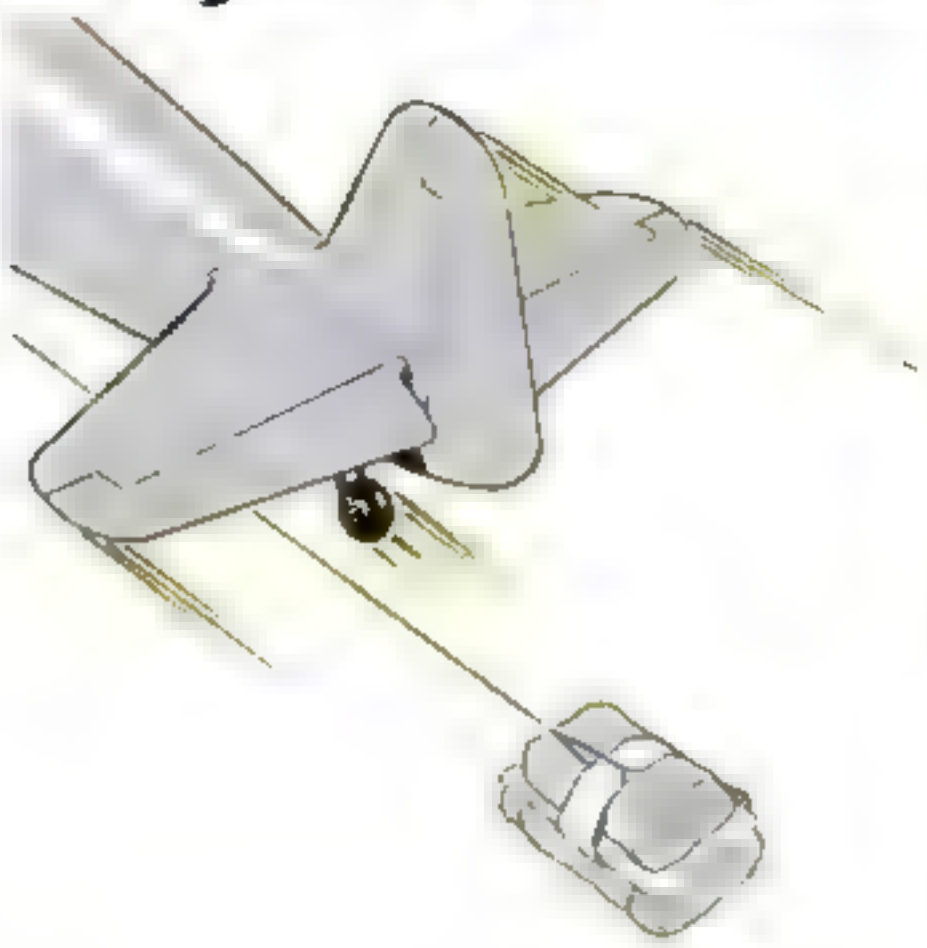
FASTEST FLYING BOAT to be built in this country, if not in the world, is the U. S. Navy's P4Y-1, which is going into production at the New Orleans plant of Consolidated Aircraft. Developed by Consolidated as Model 31, the new patrol craft uses the same Davis wing design as the Liberator bomber, with the same span of 110 feet. Two 2,000-horsepower Pratt & Whitney engines give it a cruising speed above 158 miles an hour. The new plane is intended for cargo missions as well as for combat duty, and is designed to carry a crew of seven.

HOW TO DODGE A BOMB is described by Capt. Reade Tilley of the U. S. Army Air Forces, who learned the trick in raid-battered Malta. A pencil or straight stick is aimed at the falling bomb like a pistol, as shown in the drawing at the left, and held stationary. If the bomb seems to drift upward or to one side, you are all right; but if it begins to drop out of sight, start running to either side or to the rear—and fast!

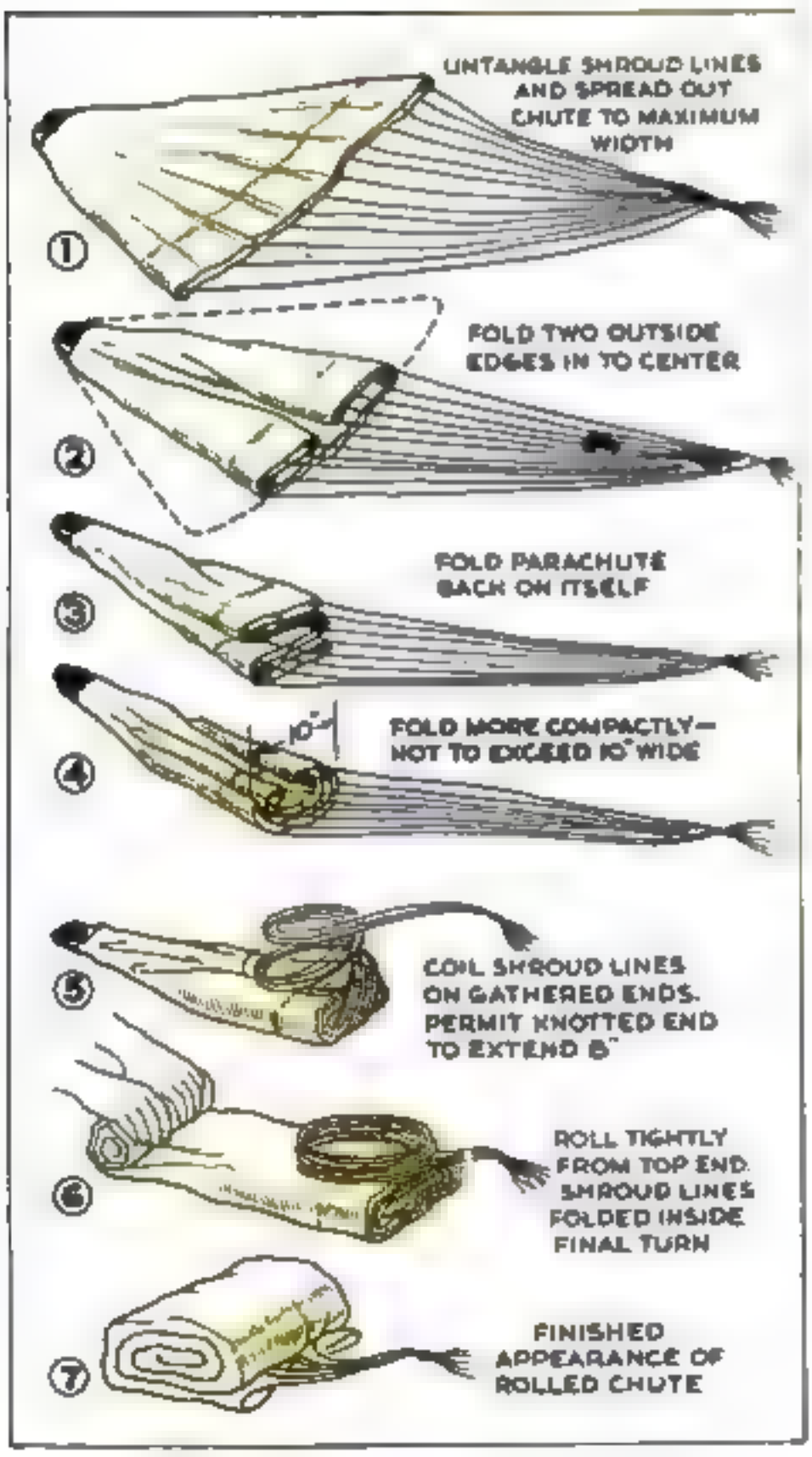


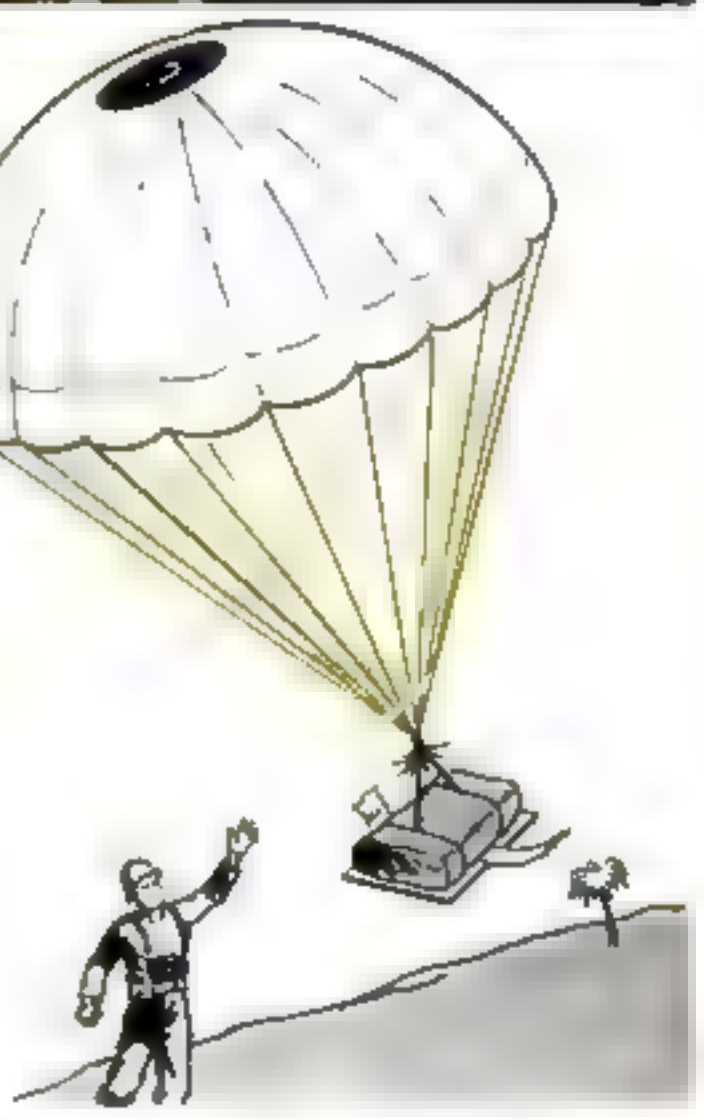
PARACHUTE BOMBS are being used with deadly effect by the Royal Air Force in its raids on industrial and military areas in Germany. This type of explosive permits the hedge-hopping tactics so disconcerting to ground defenses, since the parachutes delay explosions long enough for planes to get out of range of the blast. Another advantage of flying low is that it is almost impossible for the plane to miss its mark. The photograph at the right, recently taken at a RAF bomber station, shows one of the new big bombs just before it was loaded in a Hampden.

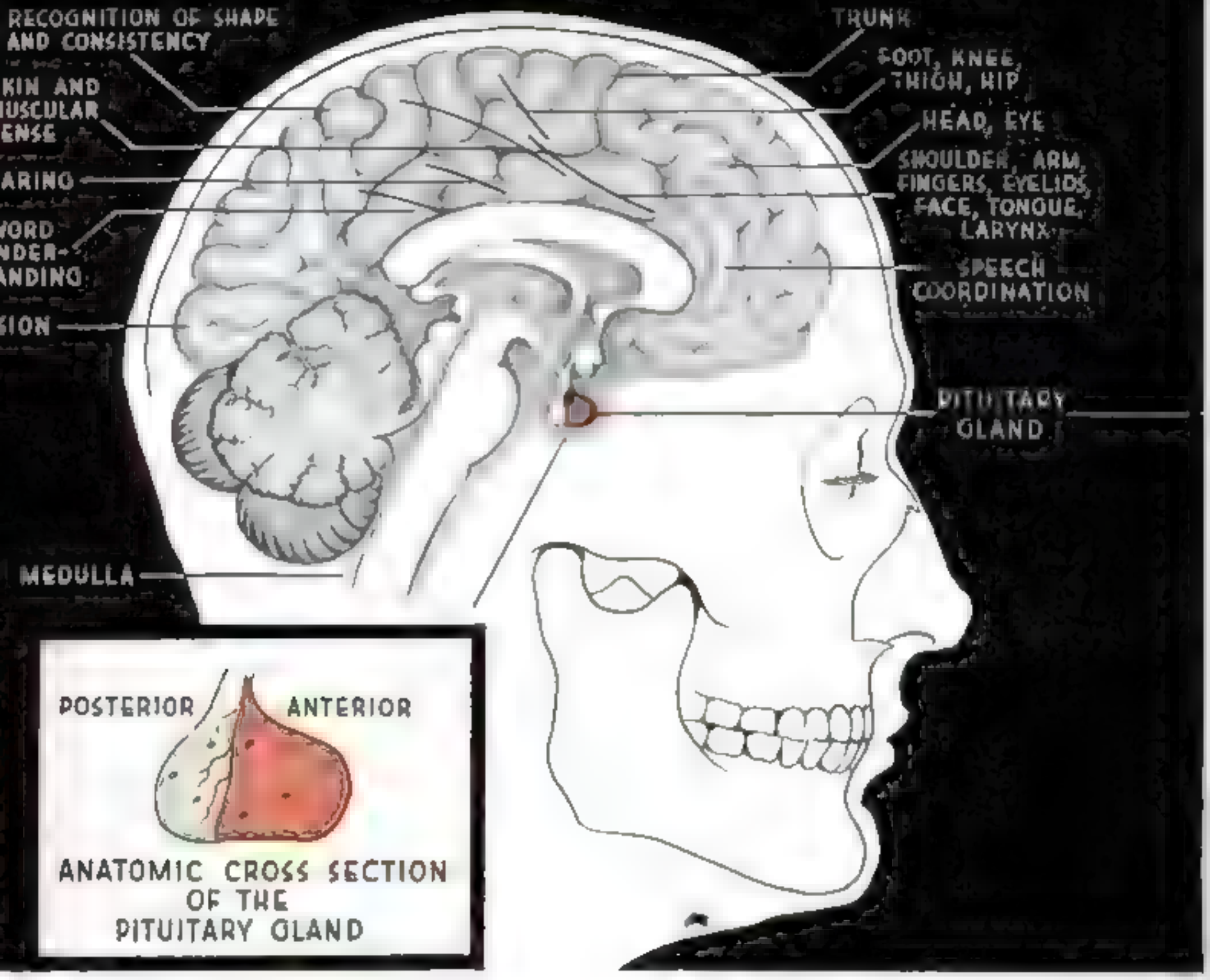
Paper Parachutes Carry Supplies



PARACHUTES made of a strong and resilient paper known as Para-Crepe have been designed for the dropping of emergency supplies such as food, water, medicine, and clothing. Tests have shown that the chutes open in from one to three seconds, make accurate descents from low altitudes, and can handle loads up to 50 pounds. A product of the Dennison Manufacturing Co., of Framingham, Mass., the sturdy chute can be refolded as shown in the drawing and used again. It weighs less than a pound and a half and helps to conserve silk for regular chutes.







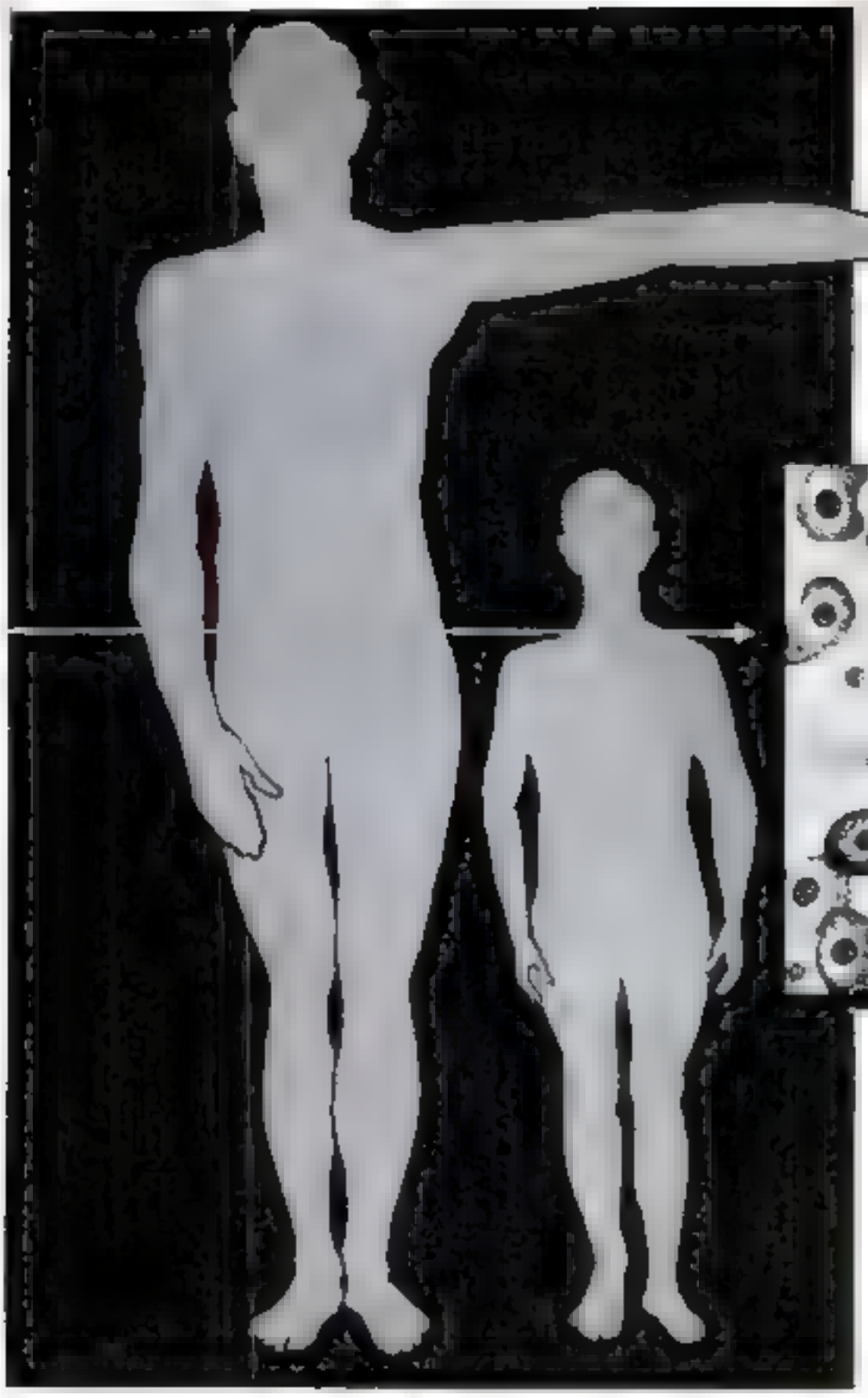
INSIDE YOUR SKULL IS THE GREATEST MACHINE IN THE WORLD. HERE'S WHAT SCIENCE HAS DISCOVERED . .

Drawings by JOHN GILMORE

CAN a phrenologist analyze your character by examining your head? New evidence convicts him as either a victim of delusion or a deliberate faker. For it throws out of court his cherished diagrams that neatly divide a human brain into centers of "combativeness," "wit," "secretiveness," and 32 other emotional and perceptive faculties.

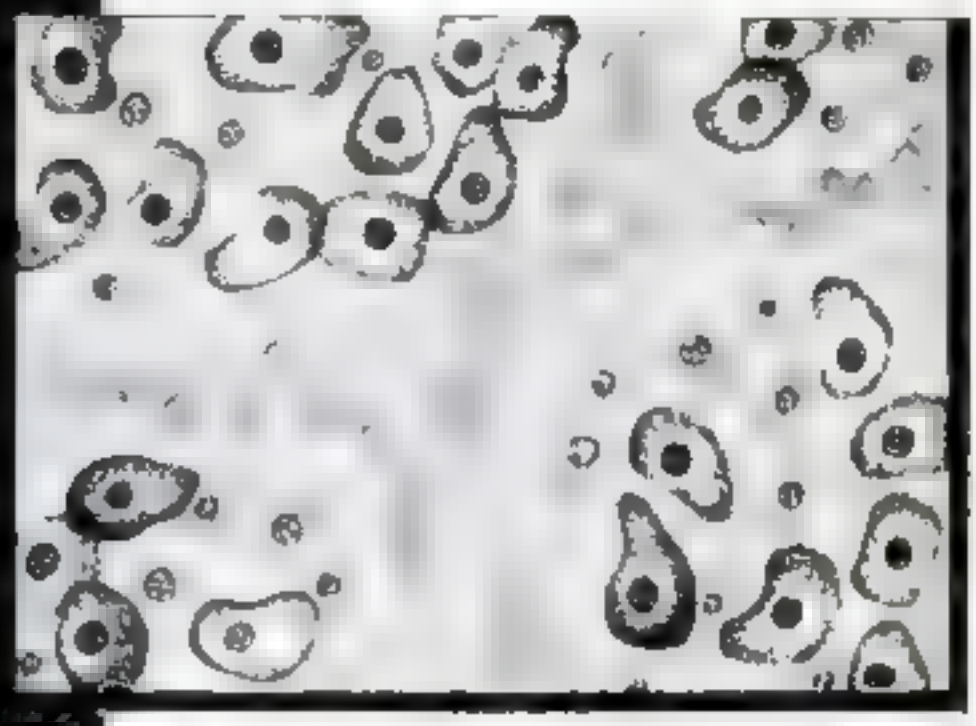
One of the most significant advances of the past few years, according to a leading neurologist -Dr. J. F. Fulton, of Yale University—has been the development of ways to find out just what the different parts of the brain do. With such laboratory subjects as the higher apes, a selected portion can be painlessly removed, to see how the animal acts without it. Observations of the effect of human brain injuries, and of operations for tumors on the brain in which part of it is lost, help to complete the picture. Some of the results of these studies appear in the authoritative drawing above. True seats of the brain's functions occupy places far removed from the imaginative conceptions of phrenologists. This explodes their only remaining claim to scientific knowledge; since their hypothesis that the brain and skull necessarily correspond in shape—a required condition to make an external "diagnosis" practical—has long since been proved false.

Modern electrical and optical instruments, including the superpowerful electron microscope, are solving long-standing mysteries of the brain and the nerve network of



THE PITUITARY IS THE BODY'S "MASTER" GLAND

Located deep in the head is the body's "master" gland, the pituitary, which has a strong influence on reproduction, sex characteristics, weight, and height. Faulty functioning may make a person a giant



or a midget. As yet, science has explored only the anterior lobe of the pituitary, the cellular structure of which is shown above. Most of the above-named functions are conditioned by this lobe. Little is known of the gland's posterior lobe other than that it secretes pituitrin, a substance with many mysterious uses.

. . . . ABOUT HOW YOUR BRAIN WORKS

which it is the master. For example, a microscopic metal electrode can now be inserted in various parts of an animal's nervous system, reports Dr. D. W. Bronk, professor of biophysics at the University of Pennsylvania. Not only does it record the passage of nerve impulses, but also the supply and consumption of oxygen during the excitement and subsequent recuperation of a nerve cell. The practical importance of such studies, Dr. Bronk points out, is shown by their close relation to the "blackout" or momentary unconsciousness of an airman pulling out of a steep dive, and to the problems of oxygen supply for stratosphere flyers. More basic in application, the electron microscope reveals the molecular architecture of isolated nerve cells.

Nature's greatest achievement, the human brain, wears a thick armor of bony skull for its protection. Through nerve fibers that radiate by way of the spinal column to all parts of the body, it performs three outstanding functions.

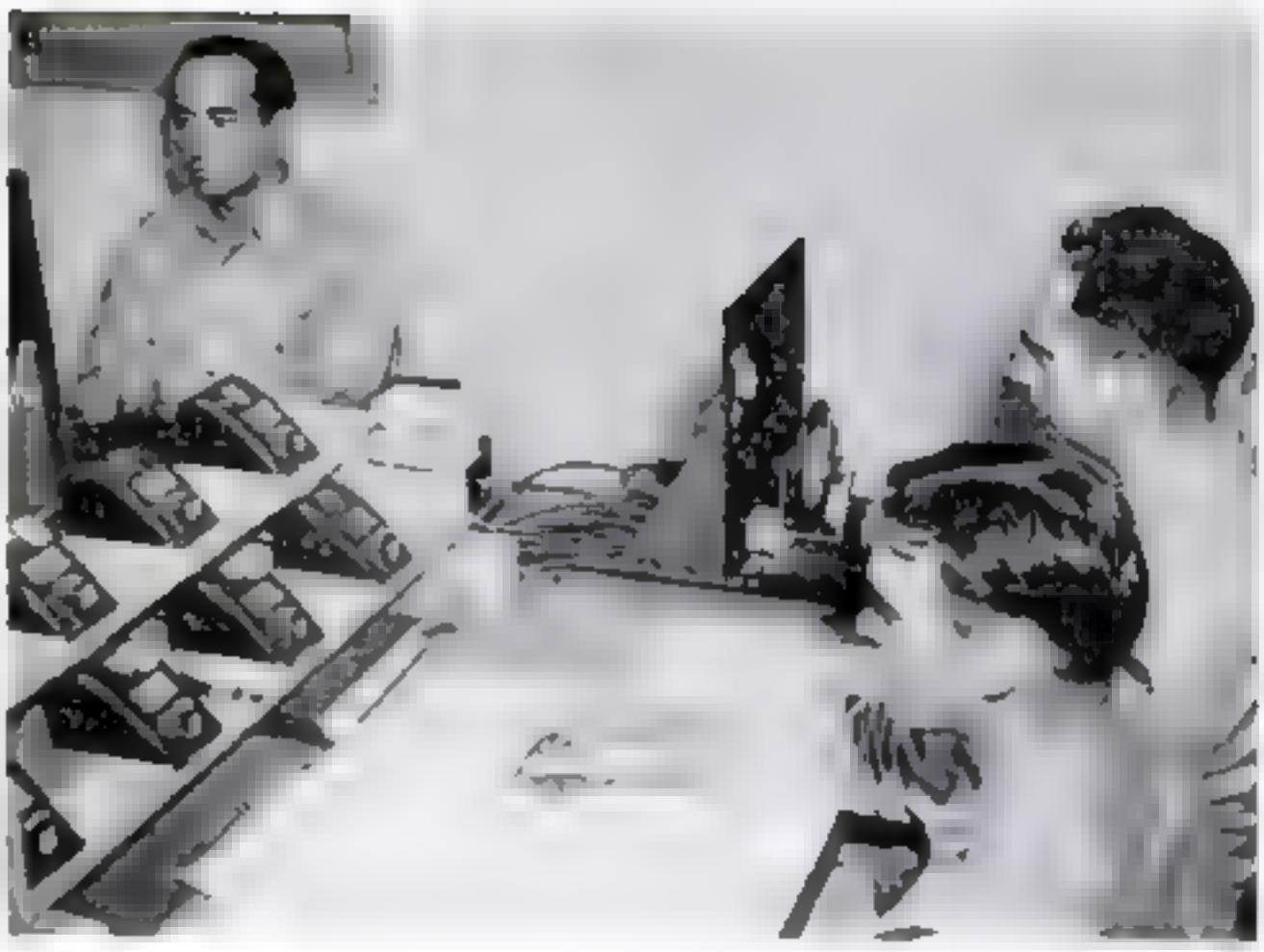
First, the brain automatically drives body machinery too vital to be left to voluntary action. All the knowledge, manual skill, or artistic ability you possess would be useless if you absent-mindedly forgot to breathe, to make your heart pump blood, or to digest your meals. Therefore, impulses from your brain take care of these responsibilities without your even being aware of it.

"Sensory" and "motor" functions comprise another part of the brain's manifold duties. Like an Army communications cen-

your gray matter constantly receives reports from the organs of the senses—vision, hearing, smell, touch, and the rest. In turn, it dispatches orders for appropriate muscles to go into action. Your ears signal that a heavy motor vehicle is approaching; your eyes inform the brain that it is your bus, and that it has stopped. Deciding that you may safely get on, your brain commands an enormous number of muscles in your legs and arms to contract in the right order to put you aboard. Here is a process of conscious thought, faster than a stop watch can time. On occasion, the nervous system can work even more rapidly, as in the classic example of accidentally touching a burning-hot stove. "Emergency!" comes a flash from the nerve-cell plates beneath the skin. Before you realize it, you have jerked your hand away. Short-circuited in the spinal column, the urgent message has been transmitted directly to the muscles that will save you from serious injury.

Highest of all the human brain's functions is its service as the seat of intellect. Memory serves as the library where every item of your experience, from earliest childhood, is pigeonholed for reference. So well thumbed are some of the volumes that you know them by heart—how to walk, to drive a car, and to carry out a myriad of simple, everyday tasks. What psychologists call "conditioned reflexes" are simply acts that you have learned to perform automatically. When an unusual problem arises, judgment reasons from past happenings. Foresight, by similar reasoning, lets you prepare for future needs.

Thousands of men for the armed services, at this moment, are taking mental tests designed to reveal how their nervous systems tick. Hardly less important are the minds of civilians, whose judgment, reasoning, and discrimination between truth and propaganda can also win or lose a war.

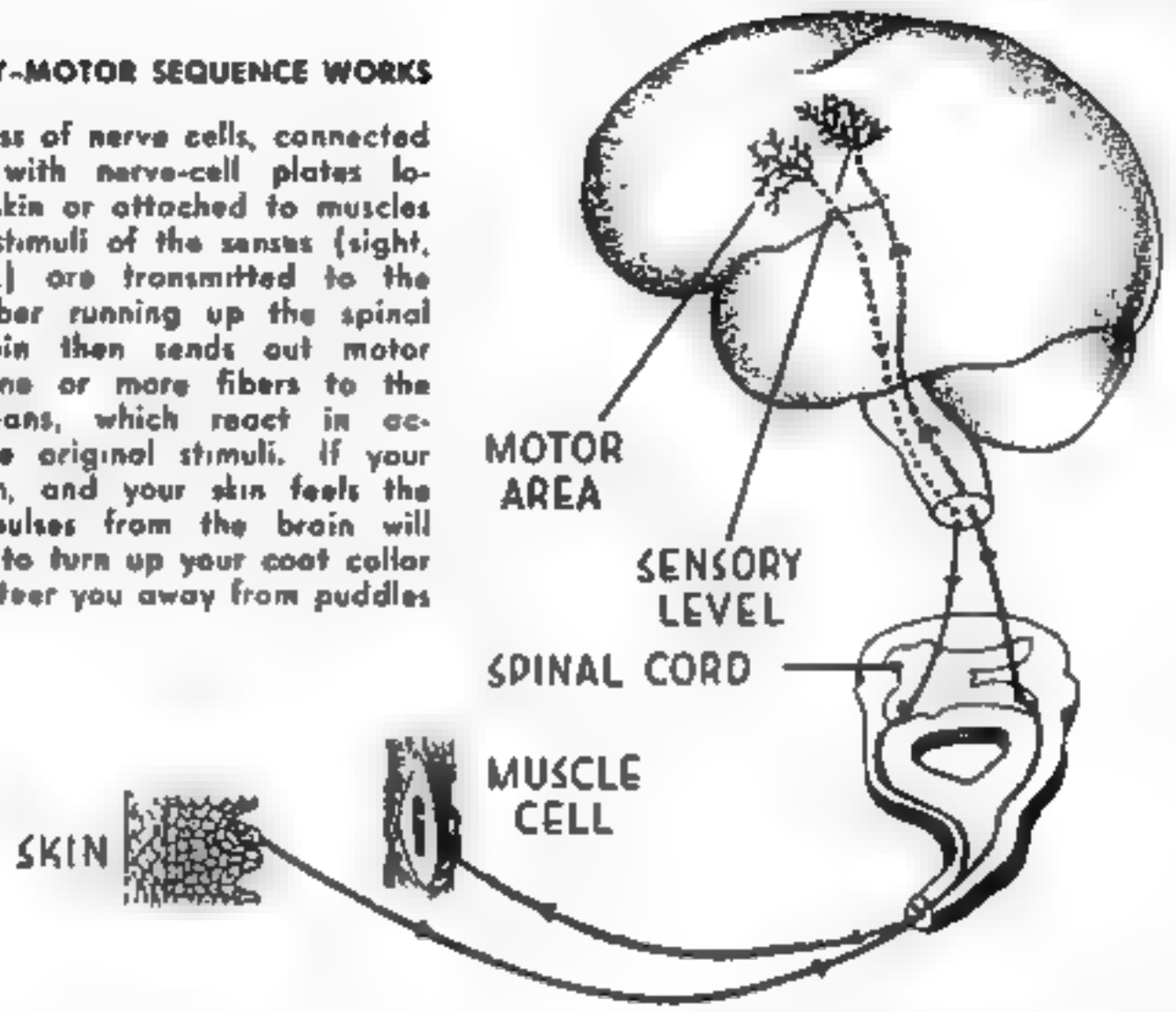


If he is physically fit, a man will usually make a good soldier. But if he has a marked ability to reason and understand, he will make a better one. The discrimination-reaction test these aviation cadets are taking is only one of about 150 different types of aptitude tests developed by psychologists to grade and classify both men and women being taken into the armed services

The flyers below are being timed as they try their hands at a bimanual co-ordination test. A staff of more than 600 officers and nearly 7,000 men have been assigned to conduct various tests of this kind at reception centers throughout the country. In the meantime, medical science is further investigating the mysteries of just how the brain controls the body's co-ordination

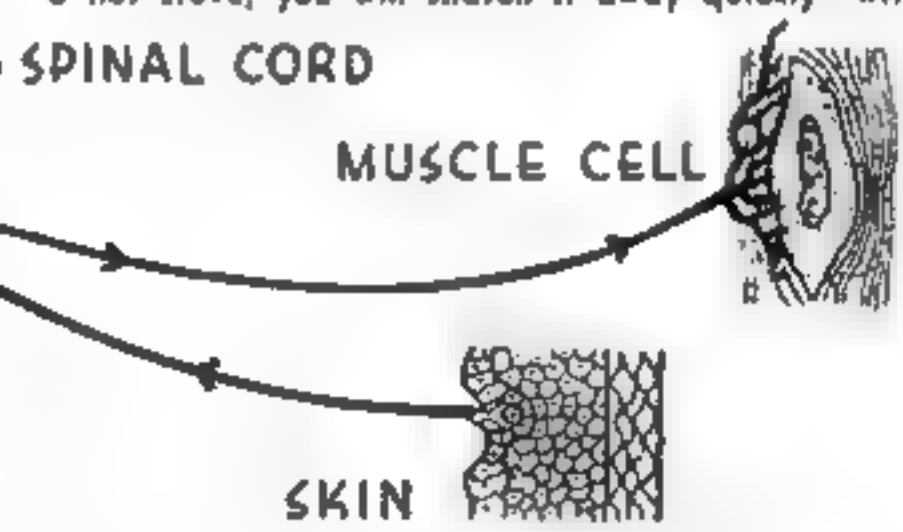
HOW THE SENSORY-MOTOR SEQUENCE WORKS

The brain is a mass of nerve cells, connected by nerve fibers with nerve-cell plates located under the skin or attached to muscles and organs. All stimuli of the senses (sight, touch, smell, etc.) are transmitted to the brain along a fiber running up the spinal column. The brain then sends out motor impulses along one or more fibers to the muscles and organs, which react in accordance with the original stimuli. If your eyes see the rain, and your skin feels the drops, motor impulses from the brain will cause your hands to turn up your coat collar and your feet to steer you away from puddles



THIS IS HOW THE SEQUENCE WORKS IN AN EMERGENCY

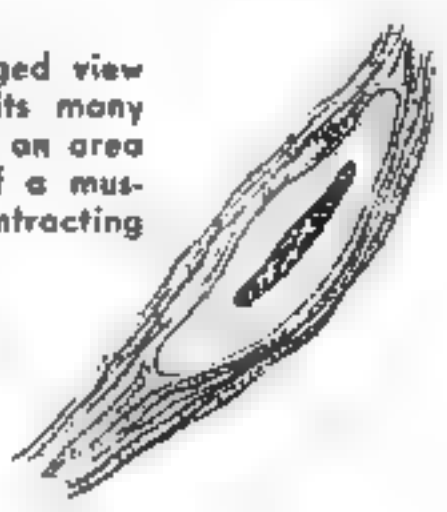
In the case of a crisis, a stimulus traveling along a sensory fiber is instantly switched in the spinal cord to a motor fiber instead of traveling all the way up to the brain. A quick movement in front of your face will cause you to blink your eyelids "automatically." If your hand accidentally comes in contact with a hot stove, you will snatch it away quickly "without thinking"



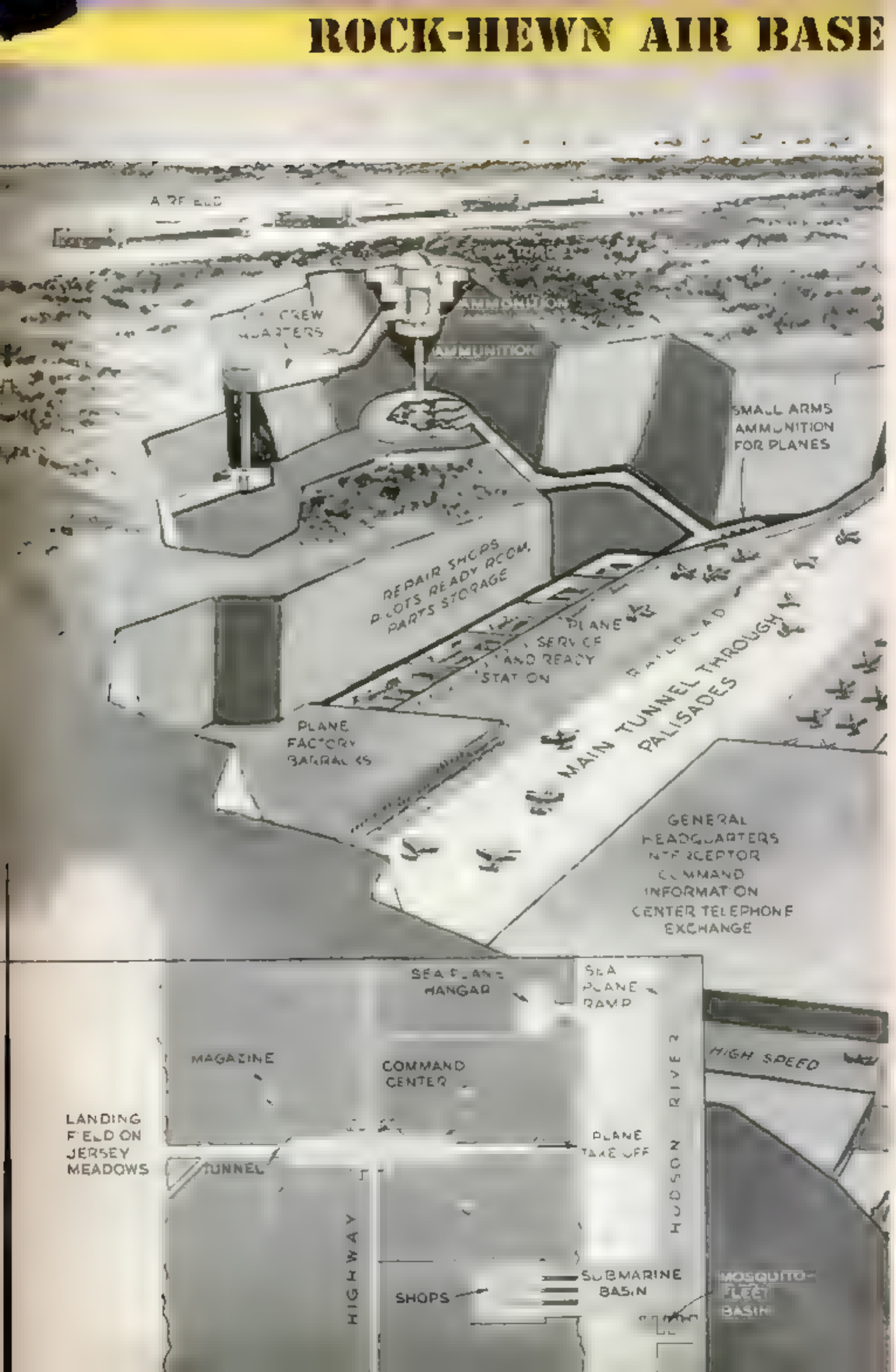
The drawing at the left is an enlarged view of a microscopic nerve cell, with its many fibers reaching out to cover as large an area as possible. Right, a similar view of a muscle cell shown in the process of contracting

NERVE CELL

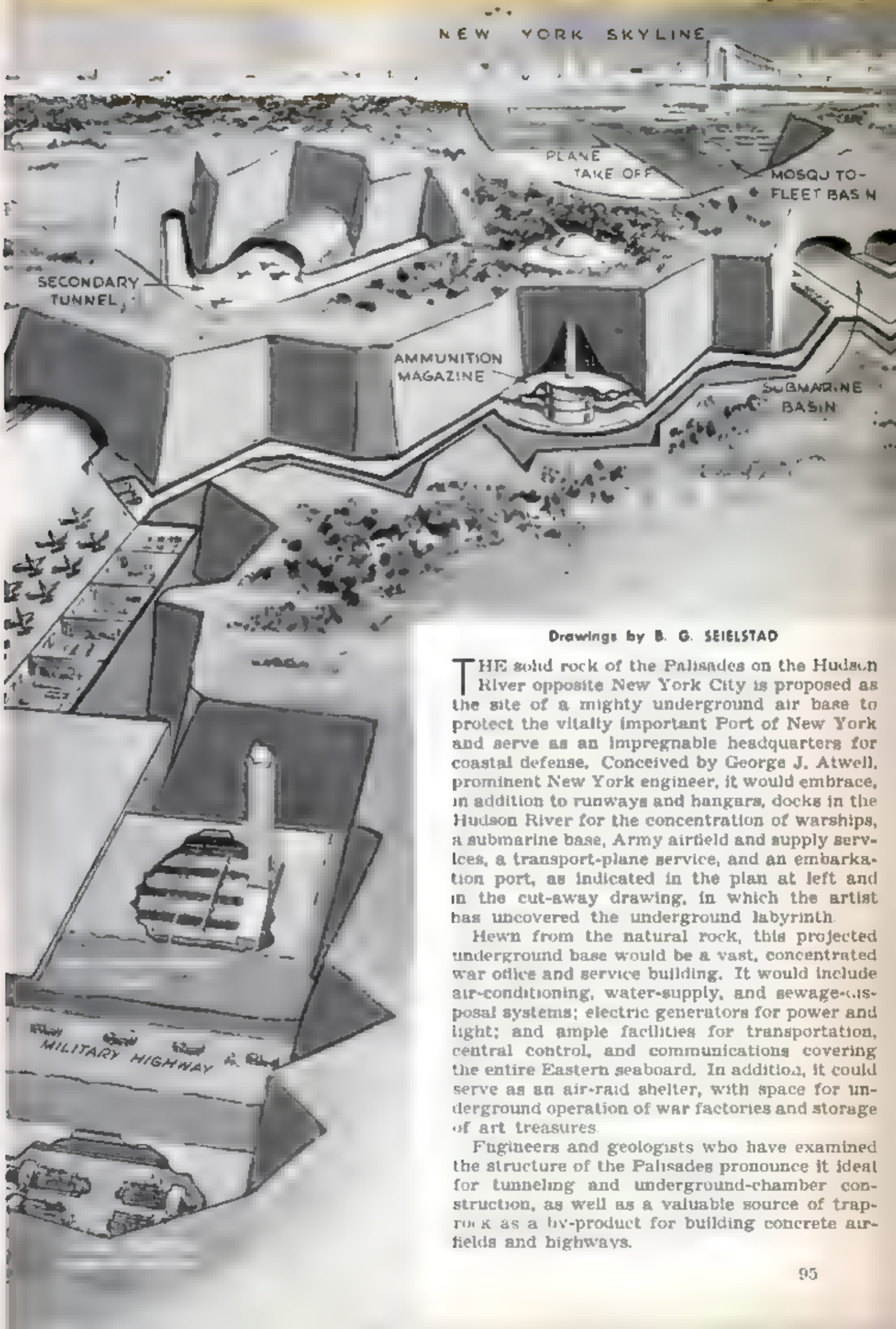
MUSCLE CELL



ROCK-HEWN AIR BASE



PROPOSED AS A U. S. GIBRALTAR



Drawings by B. G. SEIELSTAD

THE solid rock of the Palisades on the Hudson River opposite New York City is proposed as the site of a mighty underground air base to protect the vitally important Port of New York and serve as an impregnable headquarters for coastal defense. Conceived by George J. Atwell, prominent New York engineer, it would embrace, in addition to runways and hangars, docks in the Hudson River for the concentration of warships, a submarine base, Army airfield and supply services, a transport-plane service, and an embarkation port, as indicated in the plan at left and in the cut-away drawing, in which the artist has uncovered the underground labyrinth.

Hewn from the natural rock, this projected underground base would be a vast, concentrated war office and service building. It would include air-conditioning, water-supply, and sewage-disposal systems; electric generators for power and light; and ample facilities for transportation, central control, and communications covering the entire Eastern seaboard. In addition, it could serve as an air-raid shelter, with space for underground operation of war factories and storage of art treasures.

Engineers and geologists who have examined the structure of the Palisades pronounce it ideal for tunneling and underground-chamber construction, as well as a valuable source of trap-rock as a by-product for building concrete airfields and highways.

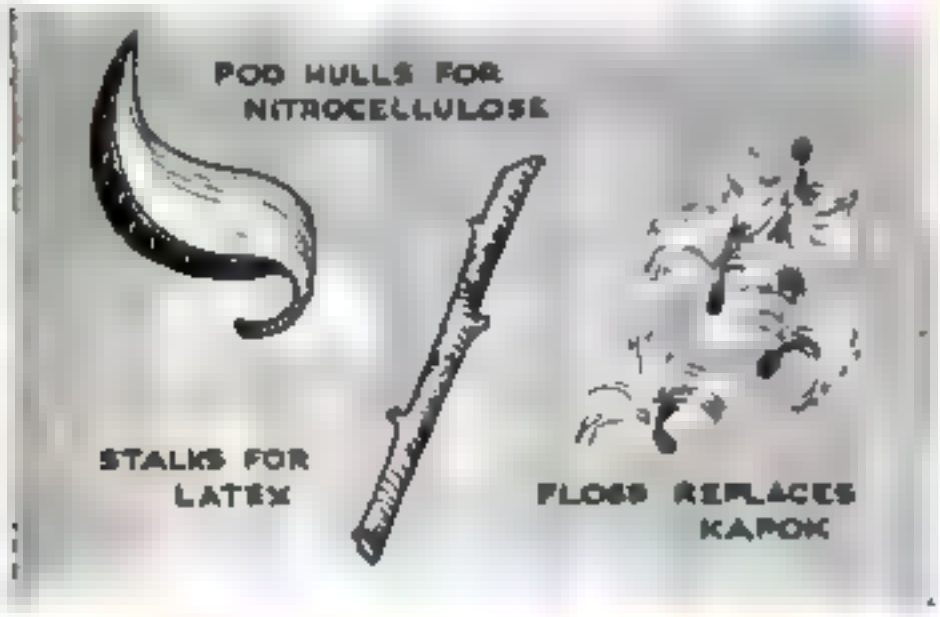
Featherweight Fillers —

DEVISED TO BEAT A JAP-MADE SHORTAGE

Kapok, imported from the Dutch East Indies, had important military uses as a lifebelt filler, shock absorber, and heat insulator. Here are some domestic materials to take its place

CATTAILS

KNOWN commercially as typha, cattail fluff is being processed by the Burgess Battery Company of Chicago to replace kapok in heat and sound insulation and, because of its buoyancy, as padding for life preservers. The fluff is pulled off the cattail stem by hand, its waste matter removed by machinery, and the remaining fluff, shown being inspected at the right, is gathered in 50-pound bales for shipping.

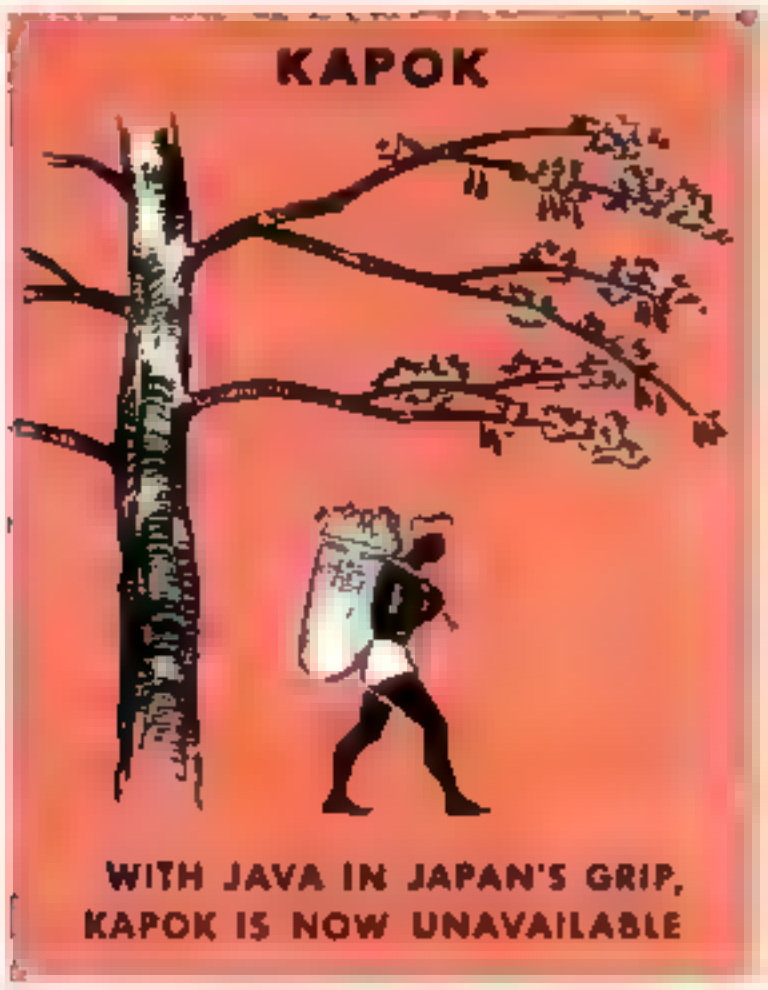


MILKWEED

ANOTHER flotation material, the equal of kapok in buoyancy, has been found in the floss of milkweed, which grows wild in vast areas of this country. The cultivation of milkweed for commercial purposes has long been the subject of experiment by Dr. Boris Berkman, a Chicago physician, who is now supplying the Navy with large amounts of the floss. Dr. Berkman's method of processing also produces such by-products as nitrocellulose, latex, and paper.

FEATHERS

"MINCED" feathers also promise to help relieve the shortage of insulation and flotation material, especially as a filler for aviators' clothing. In a process developed by Dr. J. I. Hardy, of the Department of Agriculture, poultry feathers are put in a mill which breaks the barbs away from the midribs and cuts them into small pieces. Feathers are later separated from the midribs by blowing. Microscopic hooks in the material tend to make the feathers cohere.



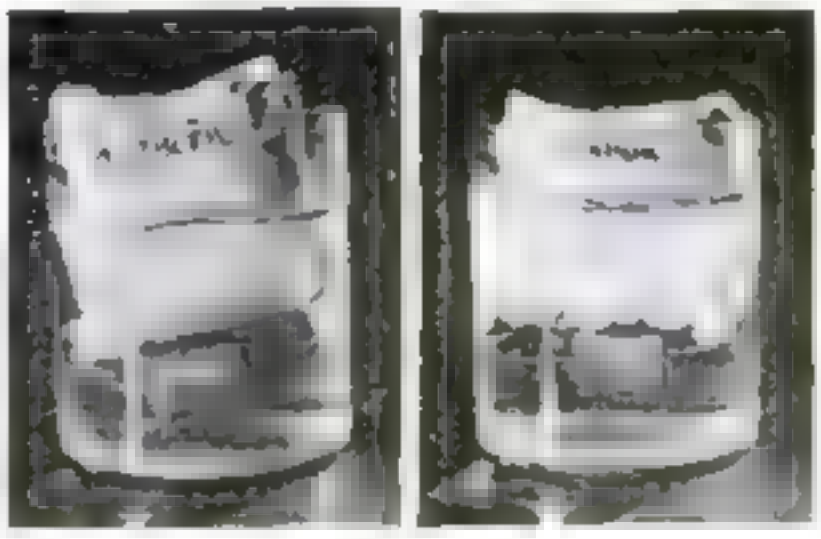
A photomicrograph of Bubblfil, showing how the tiny air pockets are individually captured in a string of light cellulose plastic

No circus strong lady is this girl holding a bale of Bubblfil. Weighing about one sixteenth as much as an equal volume of water, this light material is intended to replace kapok in life suits and life rafts

BUBBLFIL

BUBBLFIL is one of those substitutes that are proving themselves superior in many respects to the materials they replace. It is the equal of kapok in flotation, and actually retains its buoyancy longer after prolonged immersion. A Du Pont product, Bubblfil consists of a series of tiny air pockets individually captured in a string of light cellulose plastic. It is considered especially promising for use in life rafts and pontons, for should it be hit with bullets or bits of shrapnel, the puncturing of a few of its millions of air pockets will have little effect on its buoyancy. Its resilience should also make it useful as a shock absorber in planes, tanks, and other war vehicles. Foamglas (November, 1942, p. 49) is another "bubble-made" material with a high heat-insulating and flotation value. Its lack of flexibility, however, gives it different applications.

Equal to kapok in buoyancy, Bubblfil surpasses the original material in its ability to stay afloat after long immersion



Blending Metals

Alchemists of the

Special alloys go into mammoth marine gears like these made by General Electric. They will transmit power from ships' turbines to the propeller shafts

IMAGINE an exhaust valve for an airplane engine, fashioned to exact size and completely finished in one operation. Its rim consists of an alloy especially suited to holding an accurate seating surface. Its cap merges over into another alloy, adapted to resist high temperature. And the stem, made of a third alloy, resists wear as it moves back and forth through its guides.

Here is just such a problem as a designer may turn over to a metallurgist to solve. It won't be an easy one. For one thing, the alloys must expand and contract at the same rate, or strains may break the piece. But producing such tailor-made combinations, where none are already known, is the metallurgist's job. From what has been called the Iron Age, we have progressed into the Age of Alloys. Within recent years, it is said, no less than 10,000 new blends of metals have been discovered.

Probably the most out-of-the-ordinary alloy, employed in radioactive spark plugs currently available for passenger cars and motor trucks, has been developed by the Firestone Tire and Rubber Company. Nickel and a minute quantity of polonium, a member of the radium family, serve as the ingredients. Drawn into wire, the odd mixture forms the points of the plug. Since the polonium ionizes the intervening particles of gas, or makes them conductors of electricity, a spark jumps the gap with ease. This favors quick starting, even in cold weather and with a low battery. Also, the catalytic or reaction-promoting effect of the special points is said to aid combustion, giving increased power and fuel economy. Despite the fact that increasing pressure ordinarily shortens the distance an electric spark can leap, the radioactive plugs are reported to operate reliably under extremely high compression—a quality that may help to improve the efficiency of engines for tomorrow's cars. In contrast with other elements born of radium, polonium emits only harmless rays, and the plugs may be handled, pocketed, or worked over in complete safety

Whirling vanes grow red-hot under the constantly rising temperature and pressure of steam fed to modern turbines. The blades must fit within exacting tolerances for efficiency, and resist any tendency to "creep" or yield to terrific heat and strain. Alloy steels containing molybdenum, tungsten, or vanadium maintain good strength up to about 1,000 degrees F. But this safety limit now is being crowded. Operating at the record thermal efficiency of 33.5 percent, from coal to electricity, a big new Indiana power station consumes steam at an initial temperature of 940 degrees and a pressure of more than a ton to the square inch. Since there is no reason to believe that this is a limit, new alloys good up to 1,100 degrees are being developed and will be available after the war.

Another alloy known as Kovar, originally developed as a metal sealer for electronic tubes, has been adapted to measure heat in plane engines and wings by electrical resistance. When war demands depleted the supply of a special metal alloy used to make plane thermometers, Westinghouse metallurgists, by making minute changes in the ingredients and process of Kovar, arrived at an alloy that has the required properties of resistance. Four 13-pound ingots were produced, each of which has enough Kovar to make thermometers for 20,000 four-motored bombers.

Coming closer home, it matters a lot to a man and his disposition how smooth a shave he gets from a razor blade. Steel alloyed with chromium and vanadium makes a good blade—but these ingredients have become increasingly hard to get. Fortunately, metallurgists have found that more abundant "mixers" for alloy steel—molybdenum,

to Arm Our Fighting Men

Melting Pot Make the Material Fit the Job

manganese, and silicon—serve the purpose as well, if not better. Similar alloys make fine chisels and axes.

Other special purposes requiring tailor-made alloys include bits of hardware to repair human bones; nonsparking tools for workers in powder mills; plugs of low melting point for fire-fighting sprinkler systems; instruments practically unaffected by temperature for precision measurements, and apparatus capable of withstanding corrosion of all sorts, from sea spray to pow-

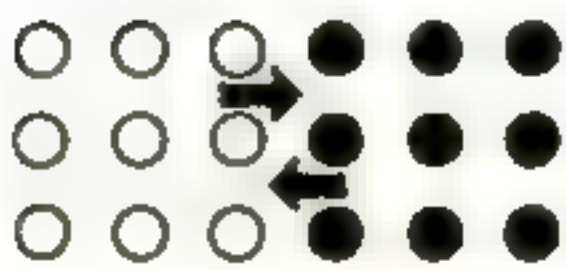
Brass is a "solid solution" produced when molten copper and zinc dissolve in each other and then solidify. Photomicrograph at right shows homogeneous crystal mixture

WHAT AN ALLOY IS

IN MOLTEN STATE, MANY METALS DISSOLVE IN EACH OTHER. NON-METALS LIKE CARBON ALSO MAY BE DISSOLVED IN MOLTEN METAL

WHEN THEY COOL AND SOLIDIFY, VARIOUS KINDS OF ALLOYS RESULT

THESE ARE FOUR KINDS OF ALLOYS:

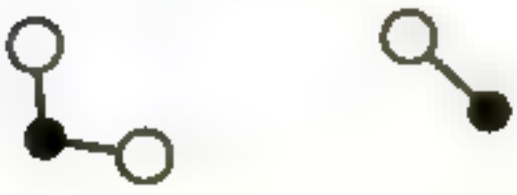


RANDOM EXCHANGE OF ATOMS
EXAMPLE: NICKEL AND COPPER

SOLUTION

LIQUID SOLUTION SOLIDIFIES TOO QUICKLY TO CRYSTALLIZE EXAMPLE: HARD STEEL (IRON AND CARBON) SUDDENLY QUENCHED

SUPERCOOLED SOLUTION



ATOMS JOIN IN DEFINITE PROPORTIONS. EXAMPLE: MAGNESIUM AND COPPER ($CuMg_2$ OR $CuMg_2$)

COMPOUND

INGREDIENTS FORM SEPARATE, BUT CLOSELY INTERMINGLED, CRYSTALS AS THEY COOL. EXAMPLE: BABBITT METAL (TIN, LEAD, ZINC, ARSENIC, ANTIMONY)

MECHANICAL MIXTURE

erful acids. By blending metals in the right proportions, and by suitable heat treatment, a skilled metalworker obtains just the desired degree of hardness, softness, ductility, structural strength, machinability, and all the other factors that suit an alloy to its job.

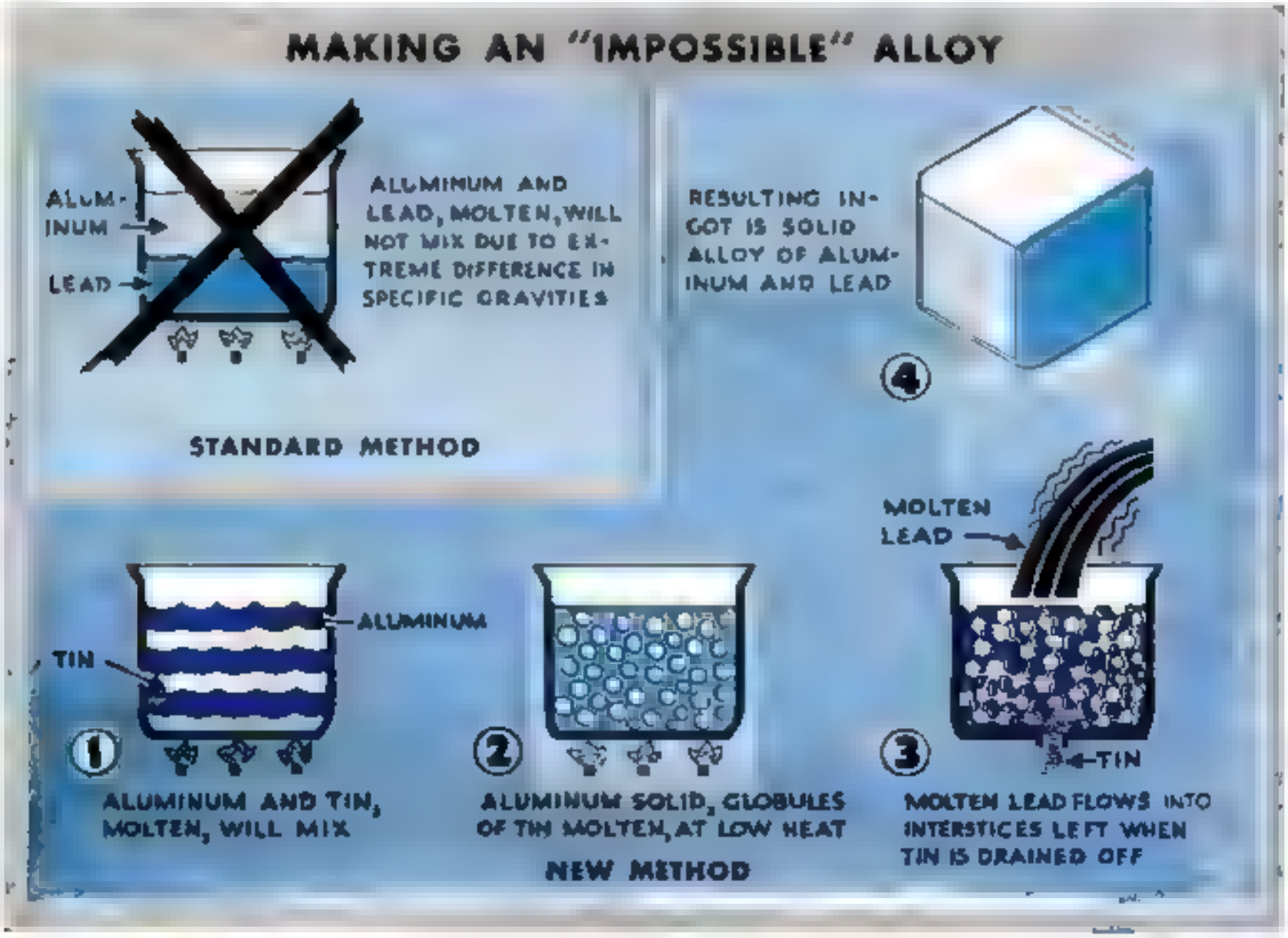
More than half of the chemical elements are metals—a goodly assortment to start with. Just as primeval forces of nature left some of them in a pure or "native" state, so natural alloys have been found—for example, combinations of silver with gold and copper. But by far the majority of pure metals, and likewise of alloys, have been created by the artifices of man.

Just what is an alloy? Copper, tin, and zinc are not alloys, but elementary metals. Bronze and brass are true alloys, produced by blending copper with tin or with zinc. In other words, alloys are hybrid metals. As used today, the word "alloy" might be defined as a solid metallic substance consisting of a solution, a chemical compound, or a reasonably uniform mechanical mixture of a metal with one or more other metals or nonmetals. Note that this definition is broad enough to include ordinary steel. Until recently, all alloys came from the melting pot, which yields examples of each type.

Most metals readily dissolve in each other when liquefied by heat. Let them cool and solidify, and you are likely to have a "solid solution"—a crystalline blend in which the identity of each ingredient has vanished. Certain pairs, like copper and nickel, form solid solutions in any proportion. Monel metal, a corrosion-resisting alloy for kitchen sinks and industrial purposes, contains about three parts of copper to seven parts of nickel. Five-cent pieces formerly were made of three parts of copper to one of nickel.

To make steel, carbon is dissolved in molten iron. If this blend cools slowly, the carbon will form separate granules and the resulting metal will be soft. But if a white-hot solution of carbon and iron is "quenched," or suddenly chilled, it solidifies too quickly for the carbon to separate, and the product is a hard steel—like glass, a supercooled "liquid." By varying heat treatments, steel of any desired characteristics may be obtained.

Metals like aluminum and lead cannot be mixed successfully while molten, because the lightweight aluminum persistently floats on top of the heavy lead. Nevertheless, an indirect method does the trick, according to a recent report to the American Society for Metals. To make an aluminum-lead alloy, the lighter metal first is alloyed with tin. Upon reheating, the tin melts first, forming liquid pools amidst a treelike pattern of solid aluminum. Now molten lead, poured over the porous mixture, seeps through it and displaces the tin, which escapes through a hole at the bottom of the vessel. Like



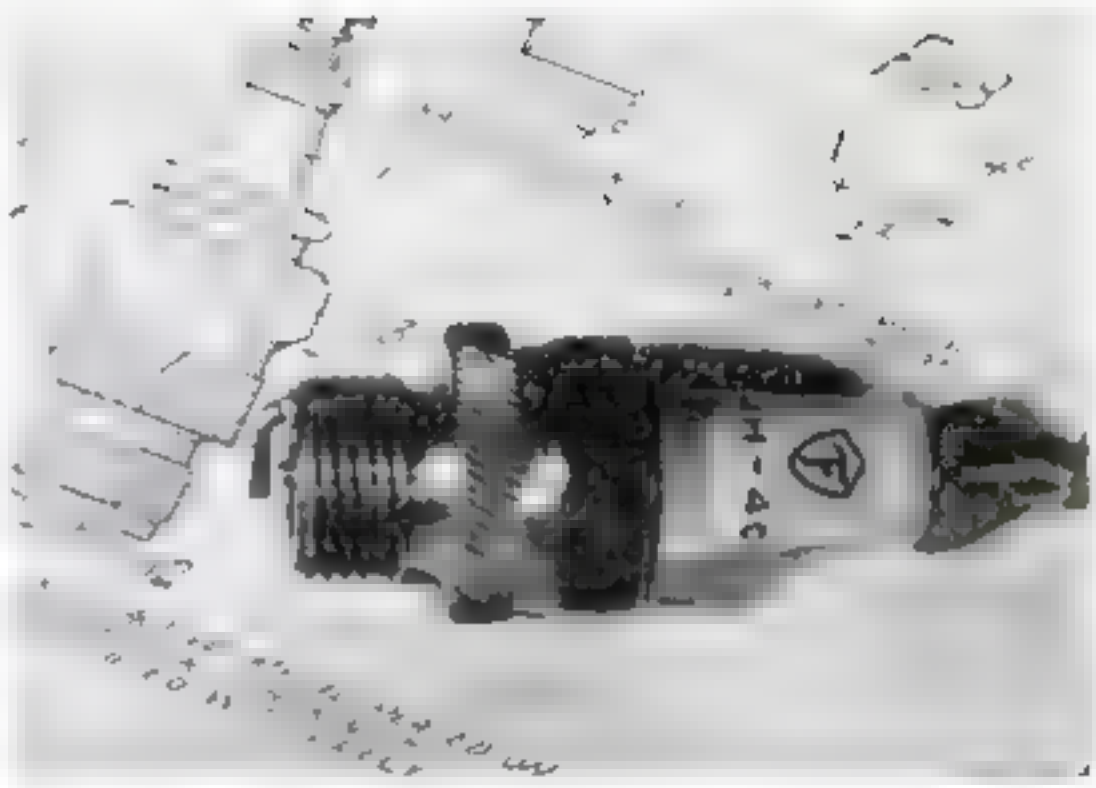
soft steel, this offers an example of a nonuniform alloy. Another is Babbitt metal, used for machine bearings, which contains a variety of ingredients. The mechanical mixture contains hard particles which take most of the load. As the bearing wears, these are pressed back into the softer matrix, so that the surface always remains smooth.

Some of the alloys that come from the melting pot are neither solutions nor mixtures, but definite chemical compounds. An atom of copper may permanently combine, for example, with either one or two atoms of magnesium, forming compounds represented by the chemical formulas CuMg and $CuMg_2$. In this case, the proportions of the combining metals are absolutely fixed.

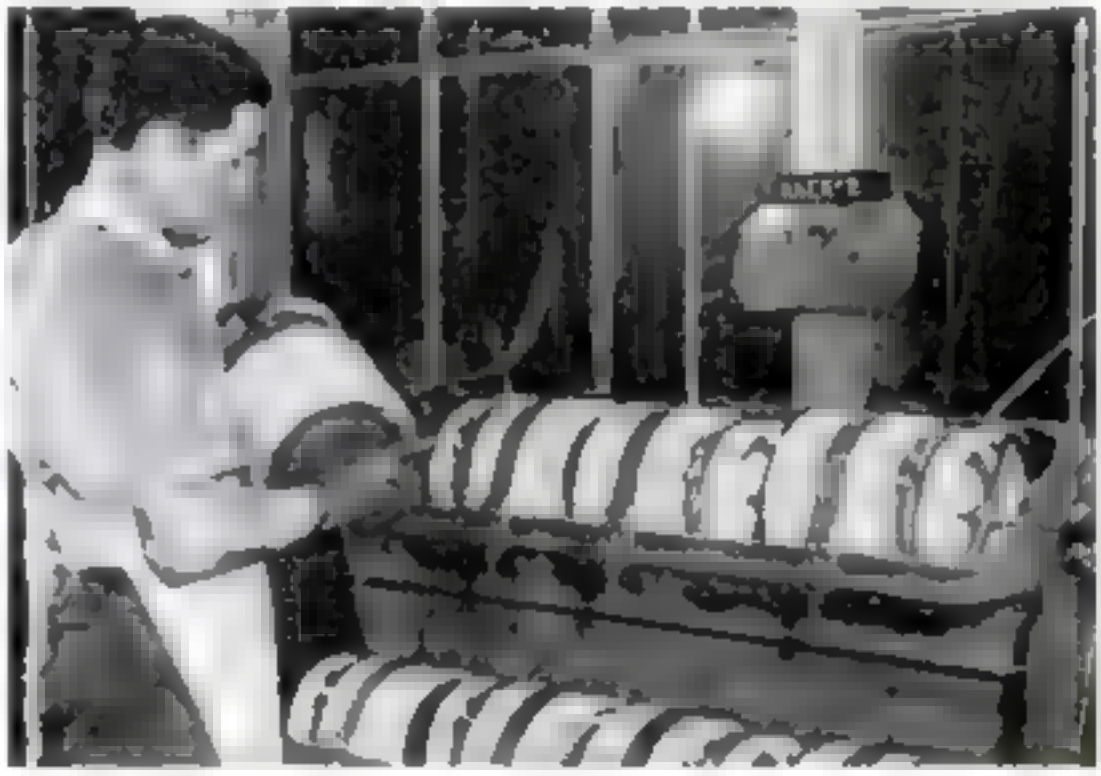
More recently, two ways of making alloys without melting the ingredients have been discovered. In one of them, called "powder metallurgy," pulverized ingredients are intimately mixed, and then heated in furnaces at a temperature below the melting point, until they coalesce. This scheme has been applied to make materials like tungsten carbide, which forms extremely hard inserts for the cutting ends of machine tools. Three powders are used—tungsten, carbon, and metallic cobalt, the last serving as a binder.

Electrodeposition, akin to electroplating, now offers a way of making alloys without heat. Its novelty lies in plating more than one metal at once. Steel hardware, for instance, may be plated with brass, from a solution supplying the metallic ingredients of the alloy. Electric outlet boxes are protected from rust by depositing a zinc-cadmium alloy upon them. Some modern bright nickel plating owes its brilliance to the fact that chromium has been used along with the nickel. While many such alloys can be made by furnace processes, the electrodeposition method is much simpler and cheaper.

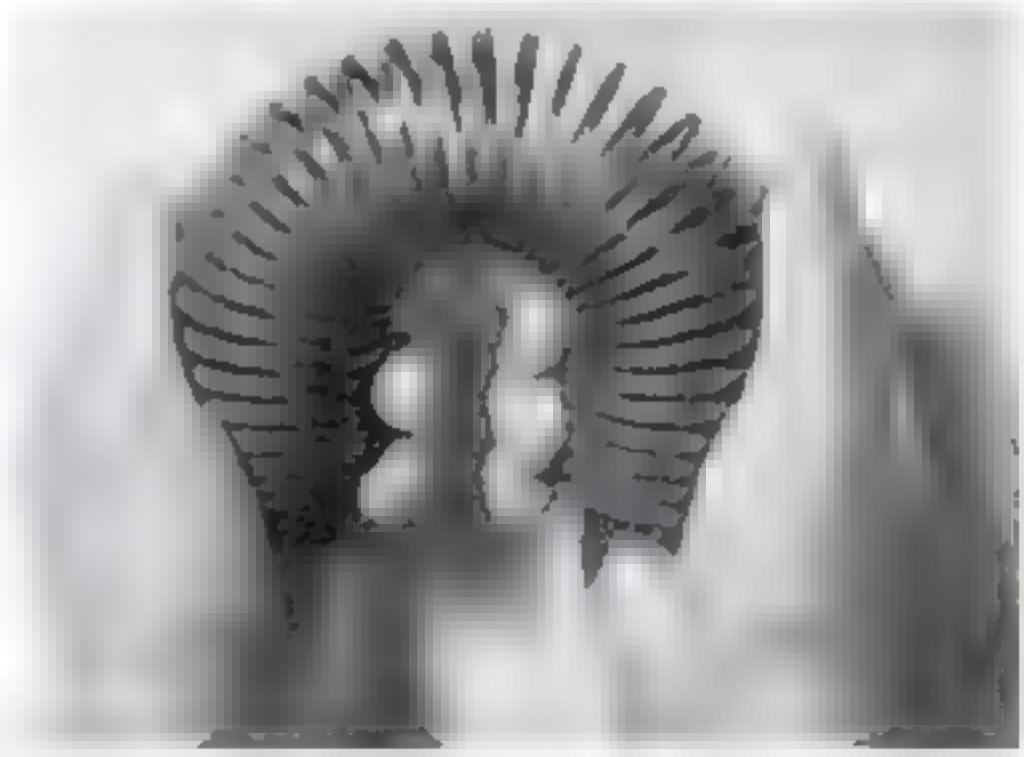
Made into alloys, metals often take on entirely new properties. Tests show that adding a teacup of silver to a ton of copper makes an alloy that conducts electricity



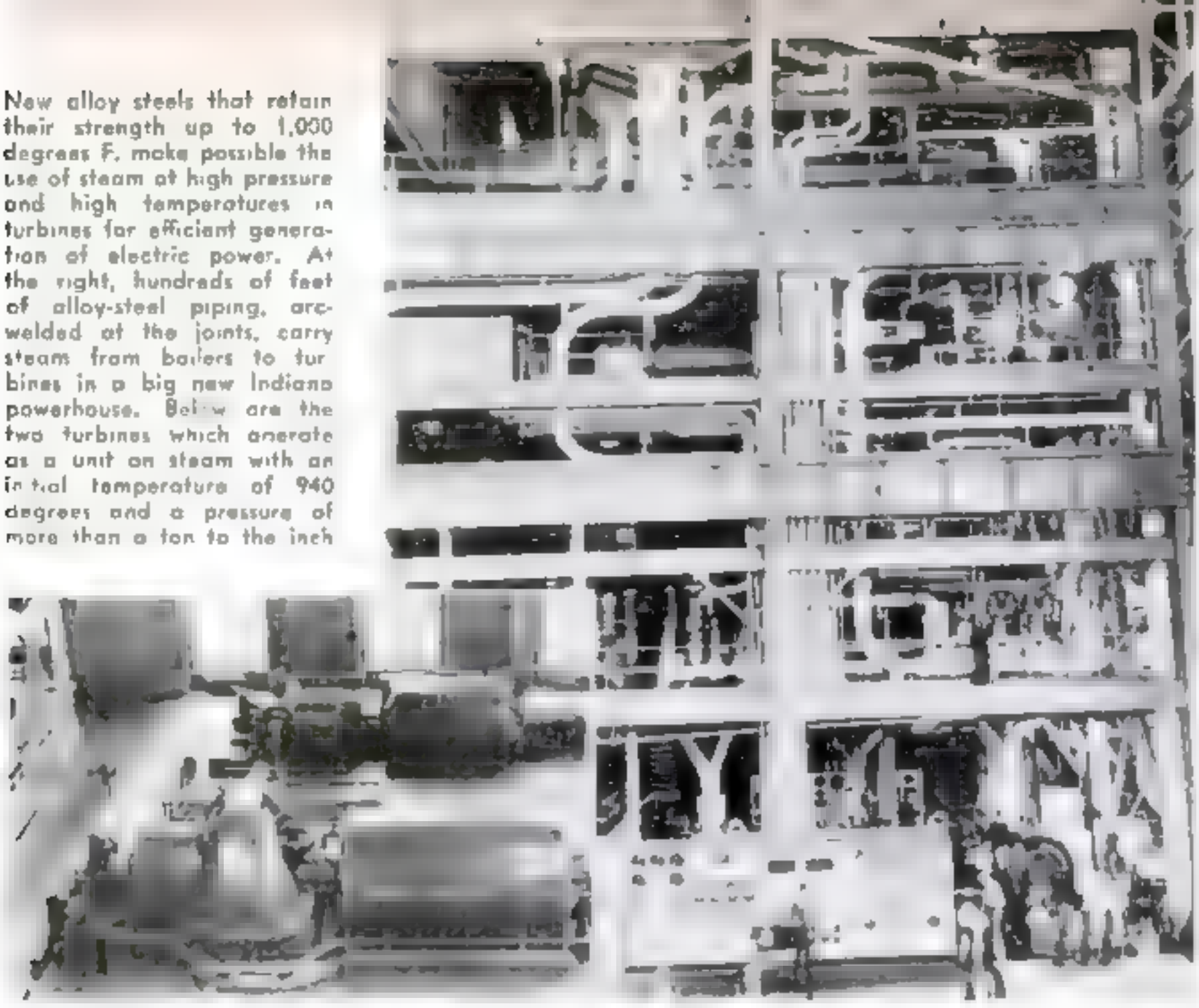
Polonium, a member of the radium family, is alloyed with nickel to form the points of this spark plug. Its rays promote quick starting by ionizing the particles of gas between the points



In "powder metallurgy," alloys are made without melting the ingredients. Here pulverized tungsten, carbon, and metallic cobalt are being mixed in a ball mill to make tungsten carbide



Flexible cast iron is another marvel of modern metallurgy. This spring was cut from a cylindrical casting of Meehanite Metal, a material being used by the Cooper-Bessemer Corporation in Ohio for castings such as crankshafts for Diesel engines



New alloy steels that retain their strength up to 1,000 degrees F. make possible the use of steam at high pressure and high temperatures in turbines for efficient generation of electric power. At the right, hundreds of feet of alloy-steel piping, arc-welded at the joints, carry steam from boilers to turbines in a big new Indiana powerhouse. Below are the two turbines which operate as a unit on steam with an initial temperature of 940 degrees and a pressure of more than a ton to the inch

just as well, and is twice as heat-resistant, as plain copper. Aluminum and gallium, a rare metal soft enough to be cut with a knife, make a bizarre combination. Aluminum does not melt below 1,200 degrees F., nor does gallium below 85 degrees. Melt the metals together, however, and the alloy will stay liquid after it has cooled! Conversely, mercury, the only liquid metallic element, forms a hard and permanent amalgam, or alloy, when it is mixed with silver or gold to fill a tooth.

All the skill of the alloy makers has now been called upon to meet the emergency of war. Imported luxuries such as tin, chromium, and tungsten can be used only sparingly, if at all. Consider that a 37-mm. antiaircraft gun uses up a ton of copper in every 20 minutes of firing, and it becomes plain why a formerly abundant metal has become scarce. So has nickel, the alloying ingredient of guns and of armor plate. Military needs tax the mines of the United States, one of the world's richest countries in natural resources, for every metal—with the notable exception of lead, of which we have enough, and of a few minor elements.

Therefore lead alloys, serviceable in thinner sheets than pure lead, today vie with copper for roofing and flashing. Indium, an unfamiliar but plentiful domestic metal, now makes a valued ingredient of bearing alloys. "Tinless bronze," containing silicon, replaces a desperately needed metal with the most abundant element, next to oxygen, on earth. Silver solder, containing lithium metal, has been found a superior material for brazing tungsten-copper electrical contacts.

By far the greatest innovations, however, have taken place in the kingdom of steel. Available alloy ingredients, and war needs, both have been shifting so erratically that mills have been fortunate to keep just a jump ahead. No sooner was a threatened manganese shortage averted than vanadium, chromium, and even home-mined molybdenum took their turns on the ration list. Metallurgists had to juggle their alloy formulas to suit.

"Lean" alloy steels, also known as national emergency or "NE" steels, have now come to the rescue. By urgent Government request, metallurgists have developed a series of steel formulas that pare to the limit the use of scarce materials formerly often employed in wasteful quantities. The result is said to equal or excel previous metals for all except a few special purposes. At least half of all the alloy steel being made today is NE steel, and thousands of tons of other ingredients are being conserved for uses where they are indispensable.

These difficulties, however, have not kept the United States from reaching a steel-

production rate of 89 million tons a year—a little less than twice the combined production of the Axis countries.

Steels containing small amounts of alloying metals are finding uses undreamed of a year ago. One of the most outstanding is to be found in aviation, where a steel with less than two percent of alloy metals has been substituted for aluminum alloy in the construction of combat training planes. This substitution has made available large quantities of aluminum for heavy-bomber construction where the saving of every pound of weight means that just that much more fuel and bomb load can be carried.

During the first World War, the Germans were said to have replaced brass with steel in making cartridge cases. When shortages of copper and zinc began to occur in this country, people asked, "Why don't we do as the Germans did?" Investigation showed that while the Germans had made the replacement, they had done so with only limited success. For barrage action and other uses, steel cases were found to be a failure. In the intervening years no nation was able to solve the problem of how to make steel cases for all guns—until last summer. Details can not be given for obvious reasons, but we can now boast that our Army metallurgists have done the impossible—for today an amazing torrent of steel shell cases is pouring out of this country into the various theaters of war all over the world.

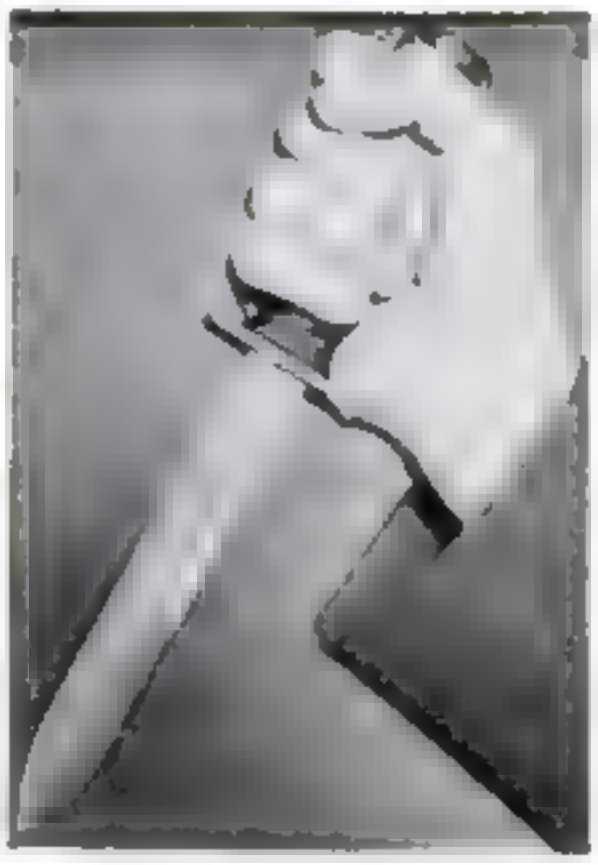
Cast iron, too, has profited from recent research. Probably the last quality a layman would expect in cast iron would be for it to be flexible, rather than brittle. Yet an improved form, called Meehanite Metal, is just that. Crankshafts made of it supplement the use of forged steel in heavy-duty Diesel engines. To convince skeptics, a block of the metal has been cut to form a coil spring about 10 inches long and two inches in diameter. It can be stretched or bent double, returning each time to its original shape.

After the war is won, alloys released from martial tasks will transform the objects of everyday life. The lightweight metals, aluminum and magnesium, will be more plentiful than ever before. Their alloys, now reserved for building warplanes, will then be able to compete in a big way with other structural metals. Combinations of little-known metals, worked out to fill imperative war needs, will challenge the dominance of long-accepted materials in all civilian fields. And many a newly devised alloy, shelved for the duration because of prior wartime needs for its ingredients, will come out of hiding to enrich our supply of materials for beauty and utility.

Turbo-superchargers that enable warplanes to fly at fantastic heights are made of special alloys developed over a period of 20 years. Driven by searing-hot exhaust gases, impeller blades must retain accurate fit at high temperatures. Here turbo-superchargers are assembled at a General Electric plant

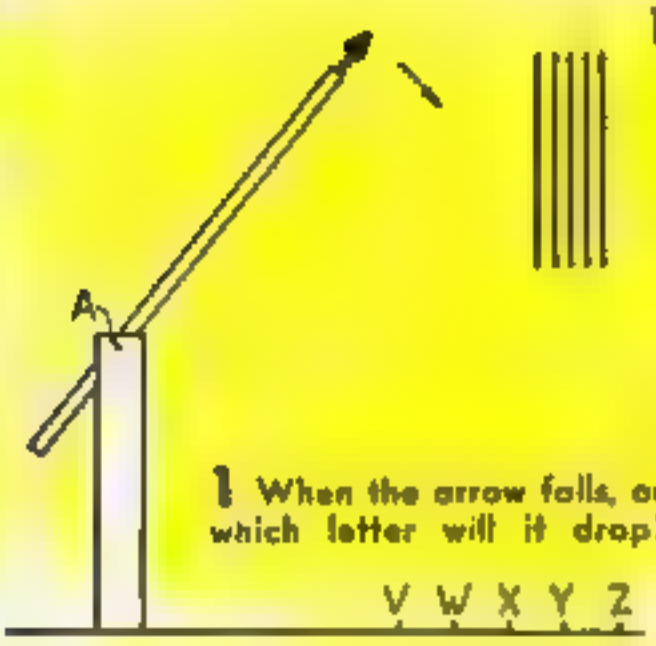
HEALTH BOMBS that exterminate disease-carrying insects are being furnished to our troops stationed in jungles. Each bomb—actually a liquid-insecticide sprayer designed to combat such diseases as malaria and yellow fever—can fumigate 150,000 cubic feet of space, or the equivalent of 240 Army pup tents. The insecticide was developed by Dr. L. D. Goodhue, a chemist in the Department of Agriculture.

A TRENCH KNIFE in which a nonslip grip of corrugated rawhide replaces the bronze handle and studded guard of the Army's previous model is designed to conserve metal. Known as the M-3, the new knife has a 6¾-inch blade of high-quality steel, and is intended for hand-to-hand combat. It is carried at the hip in a leather sheath whose lower tip can be tied firmly to the leg with a thong. It is reported that the knife will soon be placed in quantity production.



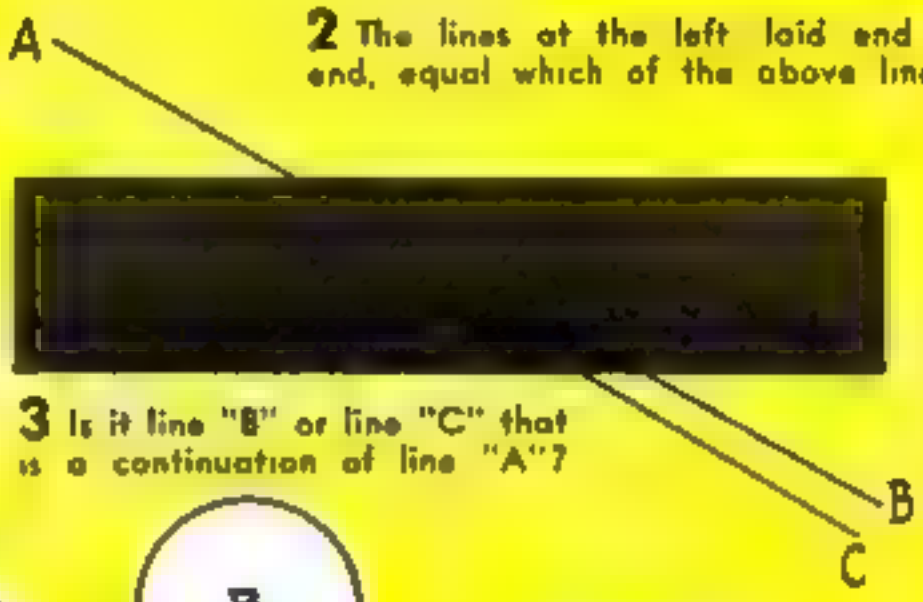
A TANK-CARRYING SHIP, fitted with a huge door in the bow through which mechanized equipment can be quickly loaded and discharged, is the latest type of vessel designed for use in landing operations. Shown at the lower right are two of a fleet of six recently launched at the Philadelphia Navy Yard. Empty, the boats in the photo are drawing about two feet of water. When fully loaded, they will draw about eight. The capacity of these ocean-going landing boats considerably exceeds that of the barges previously used in amphibian war (P. S. M., Feb. '43, p. 97).

CAN YOU SEE THROUGH THESE OPTICAL TRICKS?



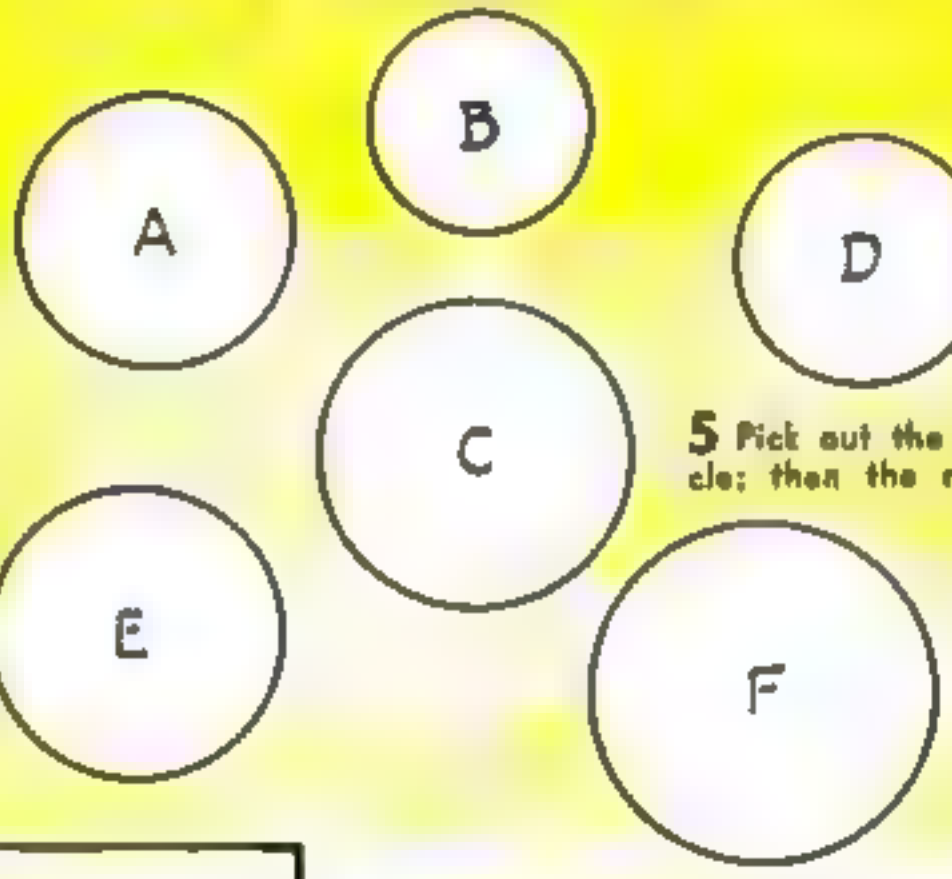
1 When the arrow falls, on which letter will it drop?

2 The lines at the left laid end to end, equal which of the above lines?



3 Is it line "B" or line "C" that is a continuation of line "A"?

4 How many turns around the pole has the stripe starting at "A" made by the time it reaches "B"?



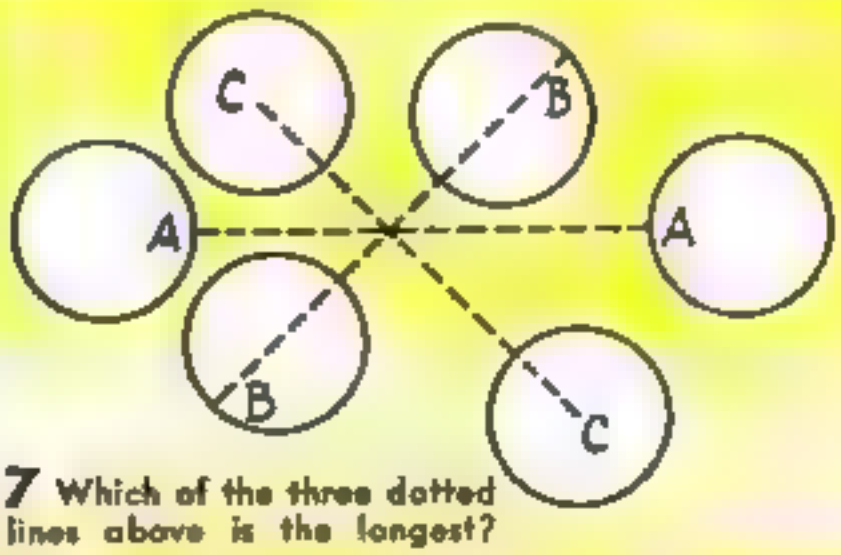
5 Pick out the dime-sized circle; then the nickel-sized one

THESE eye teasers are not as easy as they look. So study them carefully before you jot down your answers. And, of course, you are not to use a ruler nor, in the case of the barber-pole test, to count with your fingers. Just use your eyes. When you have all your answers, compare them with those below.

ANSWERS

1. It will drop on letter Y
2. They equal line B
3. B is the continuation of A
4. The stripe makes four turns
5. D is dime. E is nickel
6. Line C is curved
7. B-B is the longest

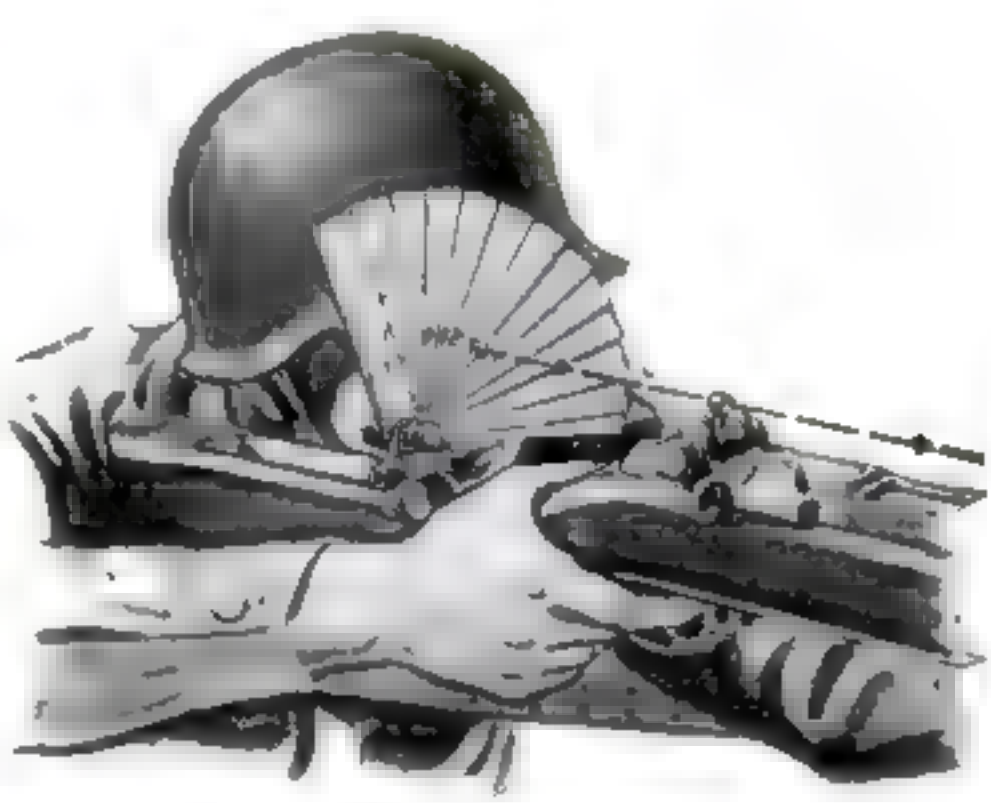
6 One of the four horizontal lines shown above is curved. Can you tell which one?



7 Which of the three dotted lines above is the longest?

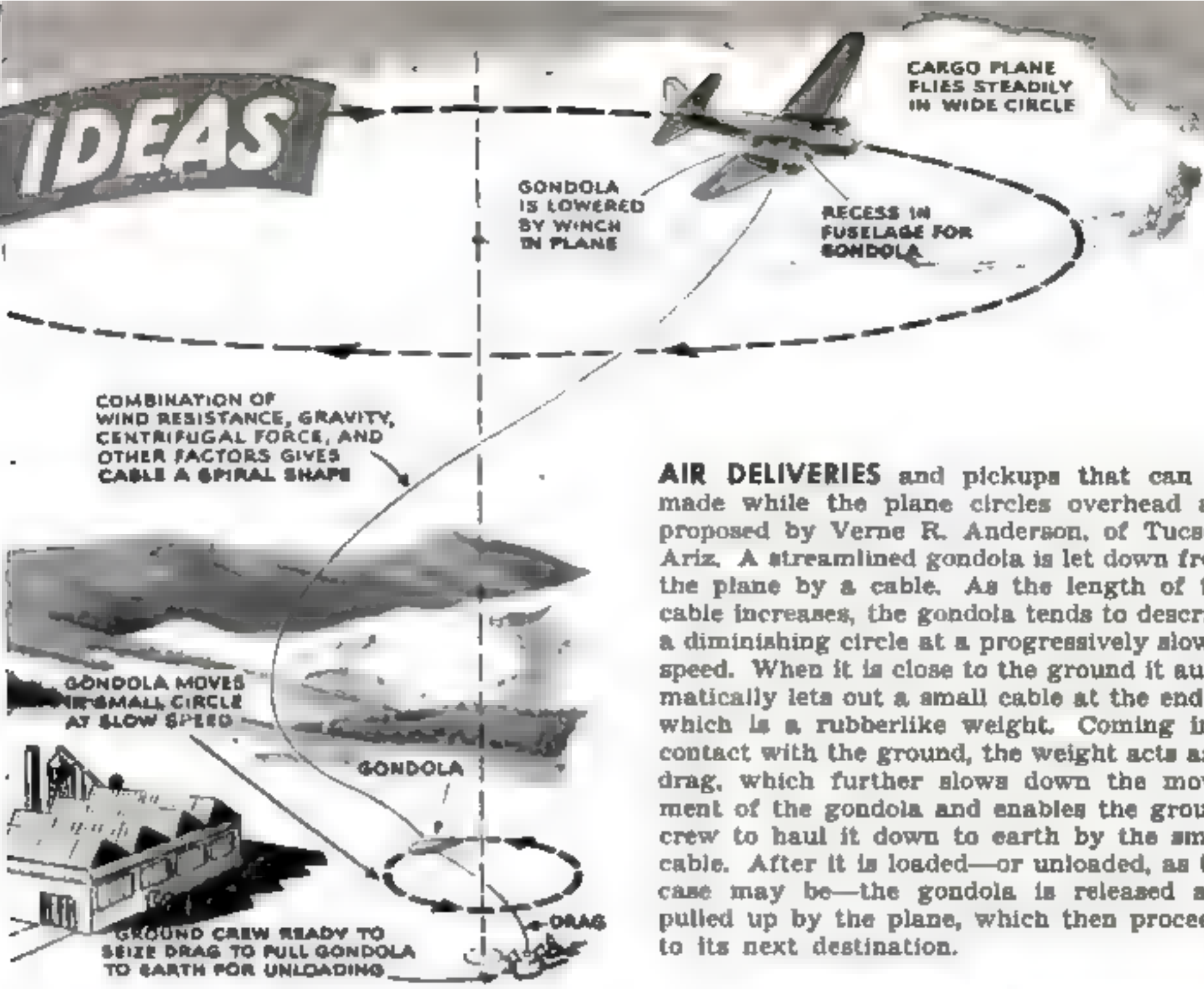
BODY BOATS are ingenious carriers which sappers of the Soviet army are now using for crossing lakes and rivers where no other means are available. Each boat consists of a pair of waist-high rubber waders at the top of which is an inflated tube that encircles the chest and is held in place by shoulder straps. Simple wooden paddles, loosely tied to the sapper's wrists so that he won't suddenly lose them in midstream, are the means of locomotion. The boats are constructed to allow enough freedom of movement for a fully equipped sapper to both kick and paddle his way across a stream, and can be quickly taken off upon landing.

A STEEL FAN, to be attached to an army rifle or similar type of firearm as a means of protecting a soldier's face from enemy bullets or flying pieces of shrapnel, has been invented by Alfred Mendel, of New York. A recess in the stock of the gun houses the folded fan, which lies flush with the stock so as to offer no inconvenience in the handling of the weapon. When the fan is raised to a protective position, the soldier sights the gun through small openings in the middle segments of the fan. The inventor points out that while a soldier's head is covered by a helmet, and the rest of his body is often protected right up to his chin by earthworks, his face is usually exposed. This highly vulnerable spot would be shielded by the proposed fan.



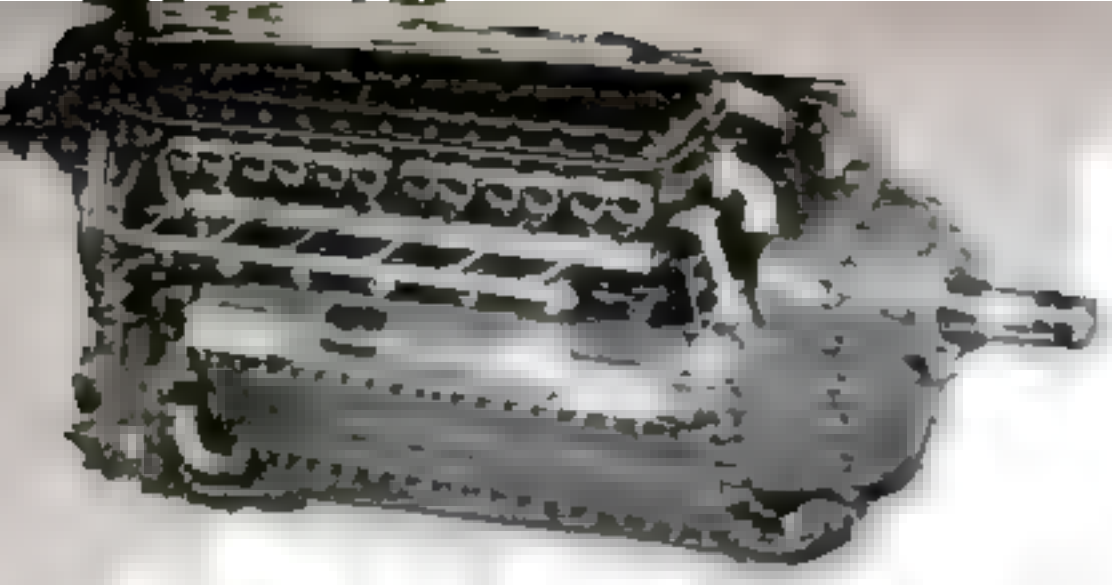
BLIND LANDINGS with greater safety are promised by a radio-beam and antenna system devised by Alfred Alford, of New York. A radiation is spread out in the form of a cone, the apex of which is at one side of the runway. A beam guides the pilot to a position directly over the runway. When the plane reaches the cone, it descends in a gentle hyperbolic curve, its wheels finally touching the the ground at the curve's lowest point.

IDEAS



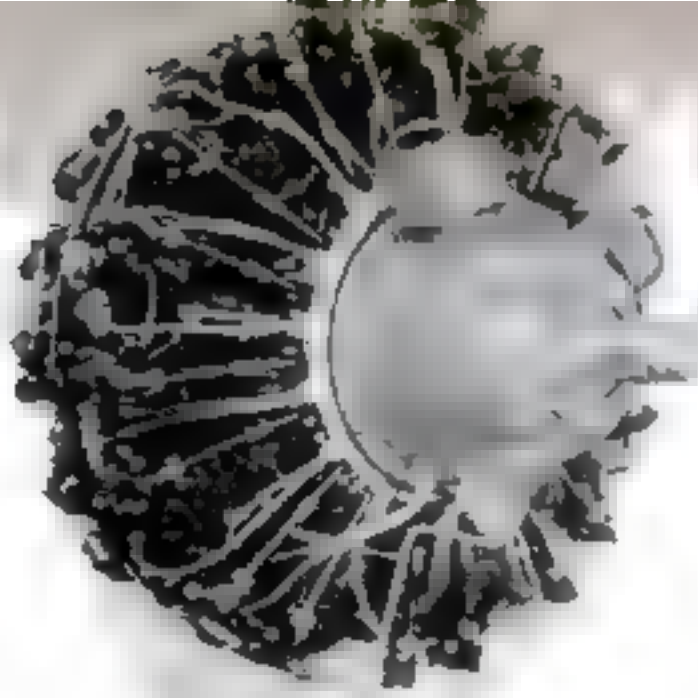
AIR DELIVERIES and pickups that can be made while the plane circles overhead are proposed by Verne R. Anderson, of Tucson, Ariz. A streamlined gondola is let down from the plane by a cable. As the length of the cable increases, the gondola tends to describe a diminishing circle at a progressively slower speed. When it is close to the ground it automatically lets out a small cable at the end of which is a rubberlike weight. Coming into contact with the ground, the weight acts as a drag, which further slows down the movement of the gondola and enables the ground crew to haul it down to earth by the small cable. After it is loaded—or unloaded, as the case may be—the gondola is released and pulled up by the plane, which then proceeds to its next destination.

SWAMP SHOES, similar in construction and use to the ordinary snowshoe, are being used by German infantrymen for crossing swamplands. The shoes are built on the spot with long flexible sticks, which are usually found in such areas. As shown below, the pattern of construction is a simple one. The sticks are merely laid crosswise, and then fastened with string, wire, or pieces of tough grass. A flat piece of wood is then attached to the center of each shoe to keep the wearer's foot from crashing through it, and the whole thing is tied to the soldier's boot with pieces of wire. As with snowshoes, the wearer uses a straddle-legged technique in walking.



ALLISON V-1710-F

Among the "big four" makes of power plants in American combat planes, the Allison (represented here by Model V-1710-F) is the most widely used liquid-cooled job. Allisons power such famous pencil-shaped U. S. fighters as the Kittyhawk, Airacobra, Lightning, and Mustang



PRATT & WHITNEY DOUBLE WASP

P. & W. air-cooled radials drive the big Liberator bomber and the fur-flying Marauder. They also power the Thunderbolt

The Truth About Our Aircraft Engines

THE FINEST AIRPLANE POWER PLANTS IN THE WORLD TODAY ARE CARRYING OUR FLYERS TO VICTORY. HERE'S THE STORY OF THESE SUPERB MACHINES AND THE BIG JOB THEY DO

By JAMES L. H. PECK

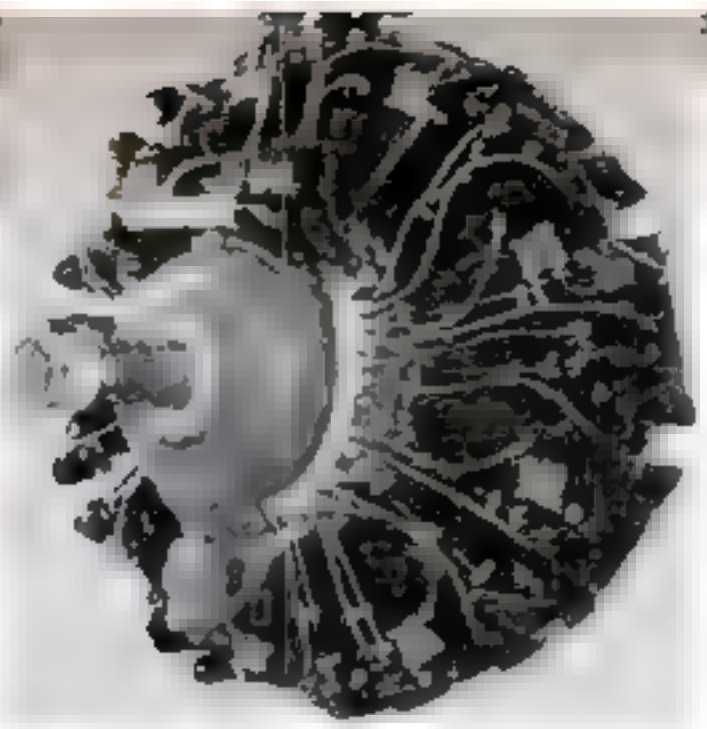
AMERICAN airplanes are winging their way over every theater of war in the spring offensive that is hacking at the heart and the outspread tentacles of the Axis octopus. With our flyers or those of our allies at the controls, greater numbers of U.S. warplanes are in the air than at any other time in history; and, more than any other single factor, it is their superb power plants that are providing these fighters and bombers with their winning performances.

The finest aircraft engines in the world are being built in this country—a fact which figures not only in the immediate air war but also in the general scheme of strategy and tactics. Of almost equal significance is the fact that these same power plants will insure the United Nations in general and the United States in particular commercial pre-eminence in the world's airways when peace comes.

It is natural that we should enjoy this engine superiority, if for no other reason than that the airplane engine is an American development. When the Wright brothers felt that they had learned enough from their early glider experiments to justify the building of a powered plane, they were unable to obtain a power plant anywhere in the country. They designed and built one of their own in the Wright bicycle shop in Dayton, Ohio. It weighed 144 pounds and delivered only 12 horsepower, but the fact remained that, for the first time, an engine had been designed which was sufficiently powerful and light in weight to permit sustained flight.

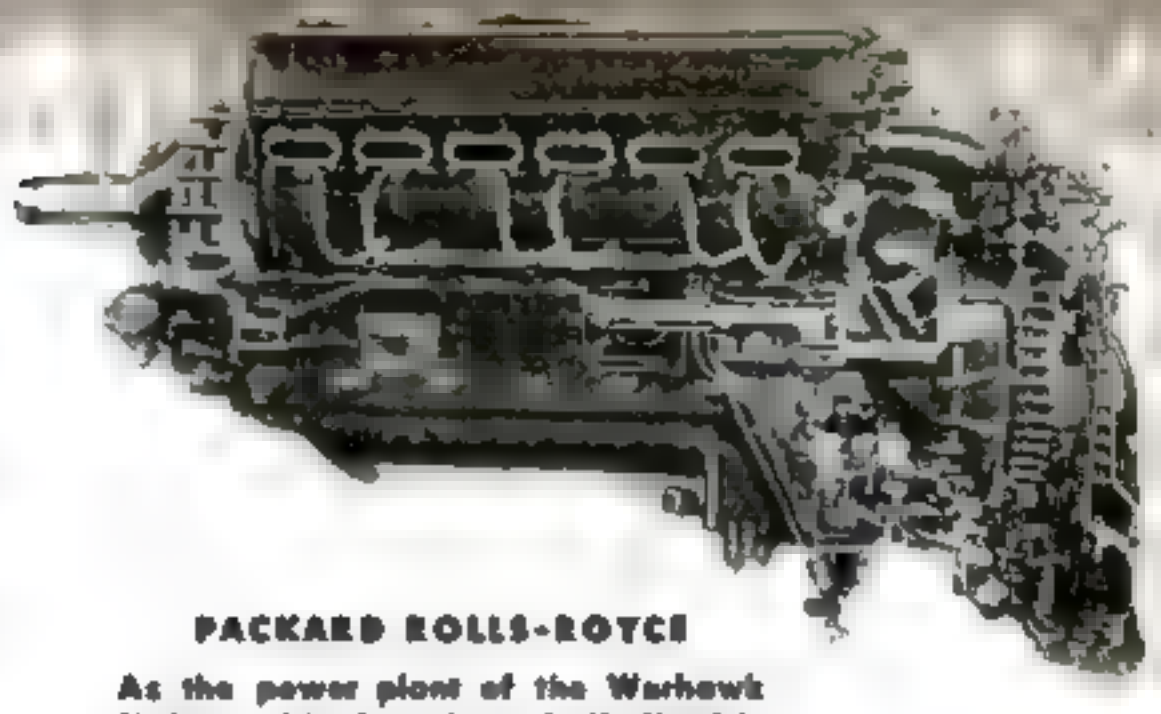
Today's miracle motors are sufficiently light and powerful to pull the 82-ton Douglas B-19 7,750 miles at a hop (with Wright Cyclones), to hurtle the Lockheed Lightning through the air at a speed well in excess of 400 miles per hour (with Allisons), or to lift the huge Republic Thunderbolt into the stratosphere (with a Pratt & Whitney Double Wasp). These three basic military engines literally pack the power of a locomotive into the space of a barrel. These packets of horsepower are concerned only incidentally with sustaining the planes in flight; they must keep 'em flying under certain conditions or circumstances which we refer to as "performance."

The plane and engine designers get together to decide how fast, how high, how far, and with how much load a given airplane is to fly in order to fulfill its tactical purpose; then they work out a compromise with the horsepower available. The packages of power they have to work with come in a wide assortment of shapes and sizes differing



WRIGHT CYCLONE (R-3350)

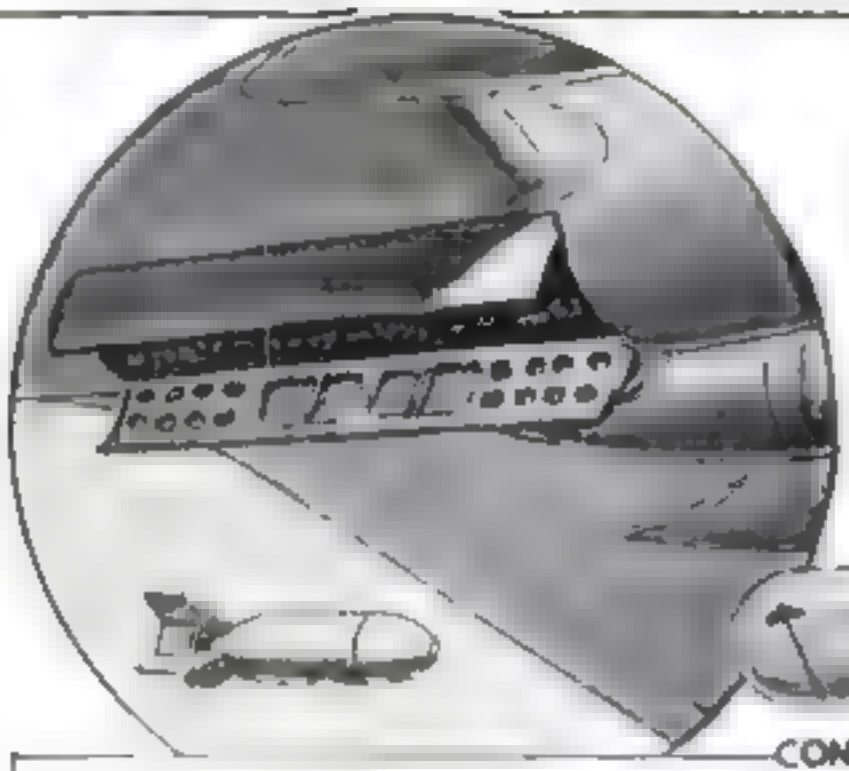
Four Cyclones carry the Flying Fortress on its devastating raids. Wright engines serve the Mitchell, Vengeance, and Havoc

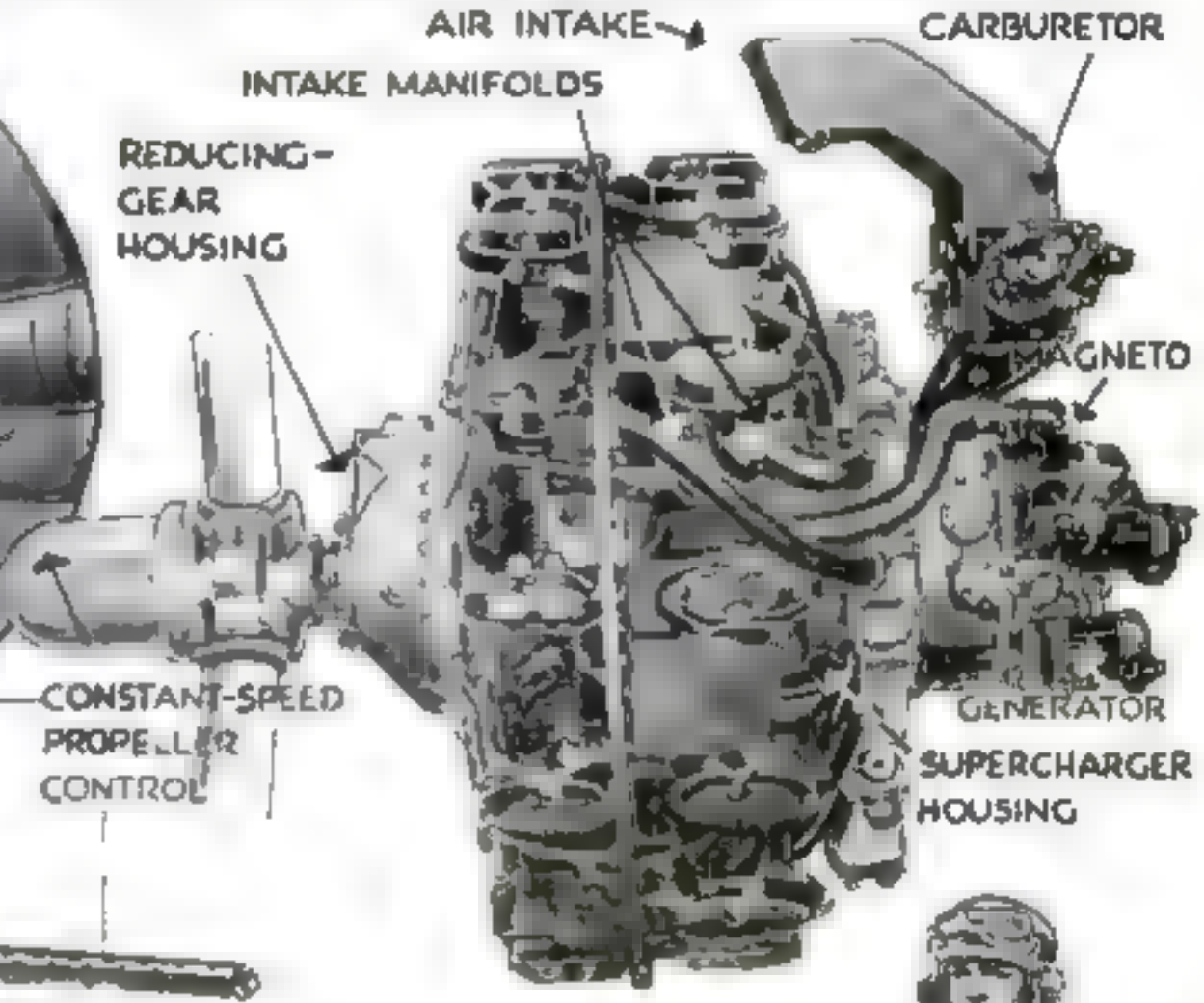


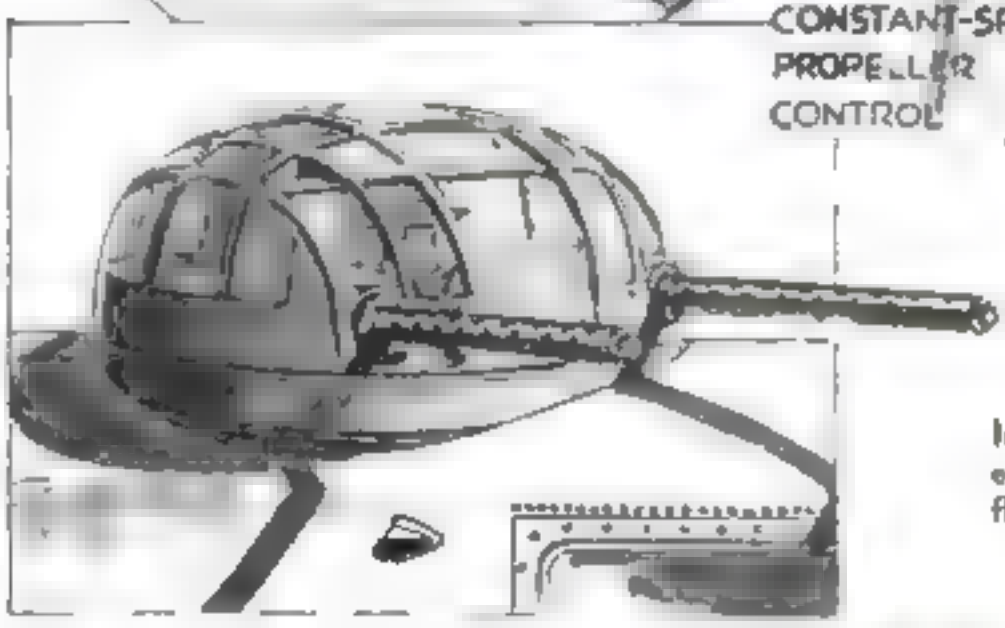
PACKARD ROLLS-ROYCE

As the power plant of the Warhawk fighter, this American-built liquid-cooled engine is in the war in a big way. The model shown, V-1650-1, has a take-off rating of 1,300 hp.

THE MODERN AIRPLANE ENGINE IS A PUBLIC UTILITY







POWER

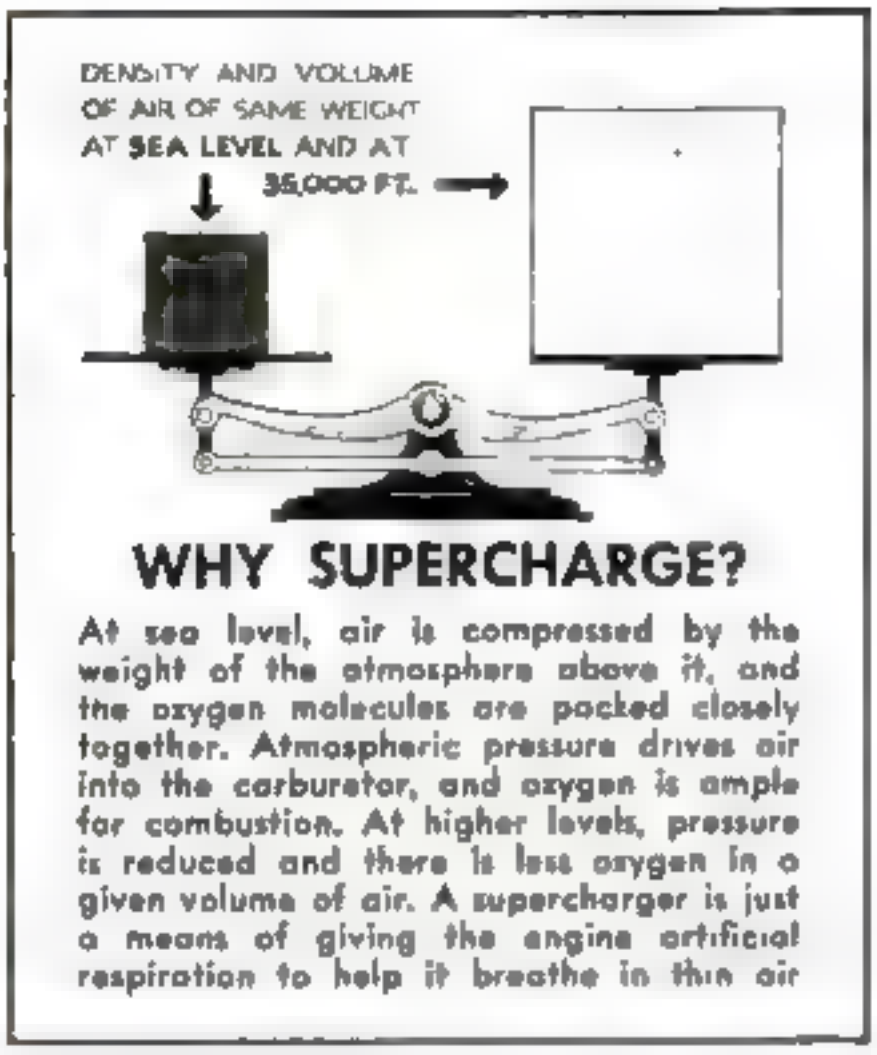
In addition to its main job of turning the propeller, the engine must sacrifice some of its power to operate the supercharger and other accessories shown in the drawing at upper right. Through the plane's hydraulic system it operates the landing gear, opens and closes bomb-bay doors, turns gun turrets, runs the automatic pilot, closes cooling flaps on the engine cowling, and does other work

HEAT

In high-altitude work, it generates current to heat turrets, flying suits, and gun mechanisms

LIGHT

It furnishes all illumination needed for night flying: lamps for instrument-panel dials, navigating lights, and landing lights



WHY SUPERCHARGE?

At sea level, air is compressed by the weight of the atmosphere above it, and the oxygen molecules are packed closely together. Atmospheric pressure drives air into the carburetor, and oxygen is ample for combustion. At higher levels, pressure is reduced and there is less oxygen in a given volume of air. A supercharger is just a means of giving the engine artificial respiration to help it breathe in thin air

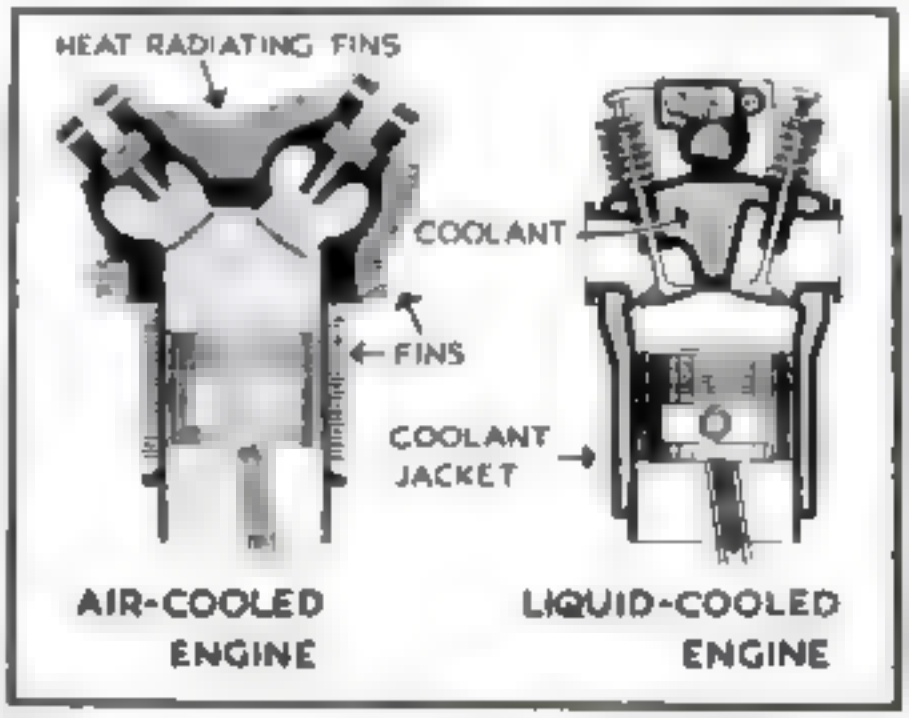
principally in the number of cylinders each type of engine has and how these cylinders are cooled.

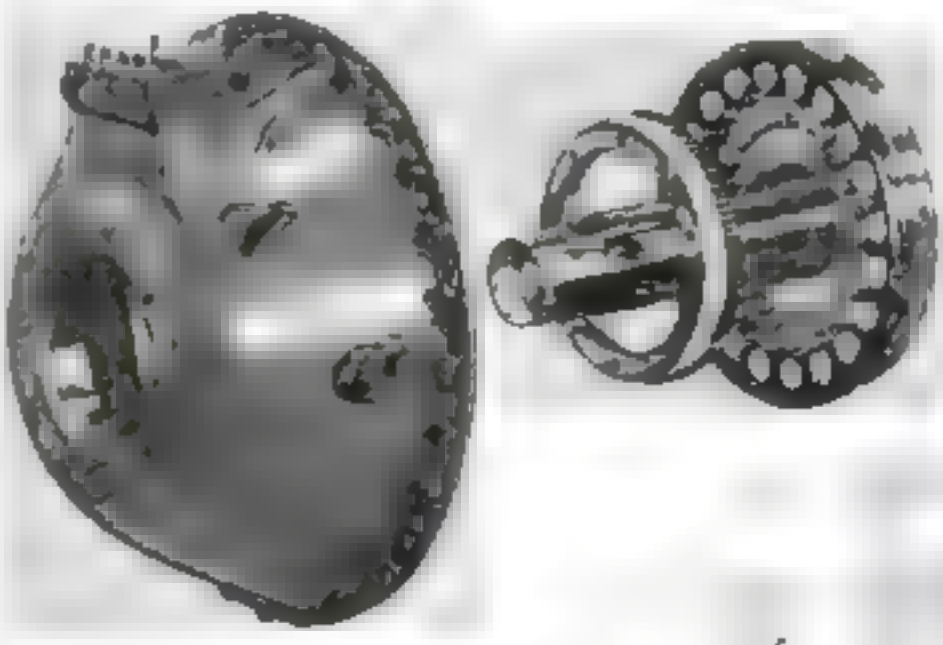
They may be exposed to the air and ringed with a number of thin fins that serve to increase the cooling surface, or they may be encased in jackets containing water or a glycol solution that is circulated around the cylinders and other working parts. In the latter case, the liquid coolant is, in turn, exposed to the air as it is pumped through a radiator. The liquid-cooled engines which are now in service are of the V type and have two banks, or rows, of cylinders to form the sides of the V with the engine's crankshaft at the apex. Other types which are going into service, or are in the final experimental stages, are the W and X-shaped engines. The former consists of two V engines that are attached to each other's sides and have a single crankshaft. The X engine is made up of two V engines set opposite each other with the crankshaft at their common apex.

The V-type air-cooled engine is coming into wide use, as is also the in-line type, having its cylinders arranged in a single row. Great things are expected of another type of air-cooled engine having two rows directly opposite each other and known as a "flat-opposed" engine. But the most popular and successful of the air-cooled family is the radial engine, whose cylinders are set like the spokes of a wheel around the crankshaft. Radials may have one, two, or three rows of the spokelike cylinders staggered compactly.

Whatever the shape or size of the power plants, engine manufacturers everywhere have a three-cornered philosophy which underlies their products. It's a sort of formula: maximum horsepower/minimum weight + maximum horsepower/minimum space + maximum horsepower/minimum fuel consumption = efficient engine.

Whether air-cooled or liquid-cooled, carburetor type or Diesel, automobile or airplane power plant, the internal-combustion engine of 1943 works on fundamentally the same principle as the ancient steam engine. In both cases heat is developed by combustion and the heated gas or steam is allowed to expand within a chamber which has one movable wall. The pressure forces this wall outward and this movement is carried through various kinds of mechanical linkage to the point where the movement can be put to work. In an airplane engine, the chamber where the combustion takes place is called the cylinder; the movable wall is the piston; the mechanical linkage consists of an articulating rod, or connecting rod, which is fastened to the engine crankshaft to translate the straight up-and-down movement of the piston into rotary motion.



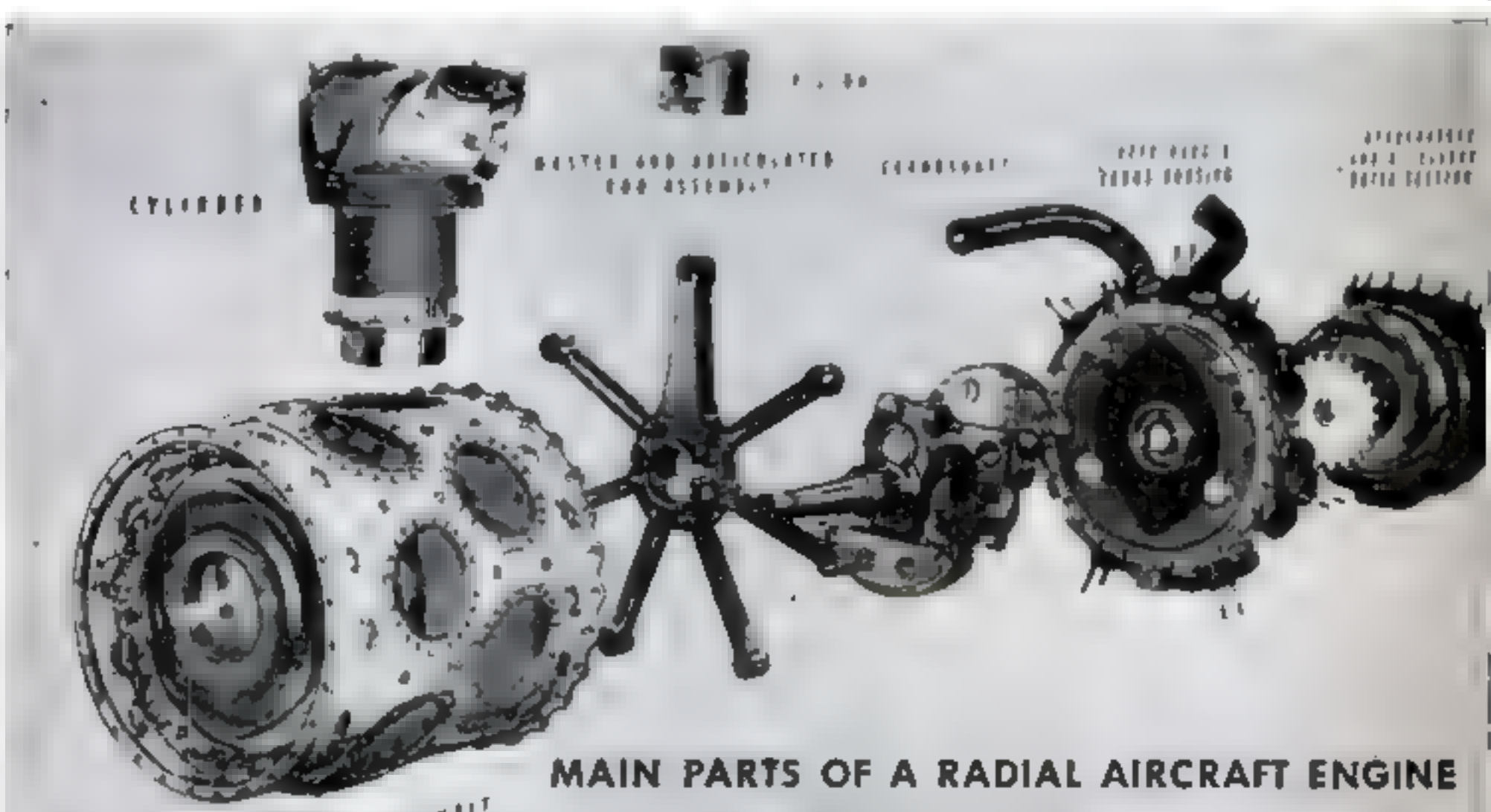


Let us consider what happens inside the cylinder of an aero engine such as the Wright Cyclone. In principle, a single cylinder is an engine in itself. At the top are two ports through which the fuel-air mixture is drawn in and the burned exhaust gases expelled; these ports are sealed by valves that open and close in carefully timed movements as the vaporized fuel enters and as the gases are exhausted. The first of the engine's cycles is the intake stroke, during which the intake valve opens as the downward movement of the piston results in a partial vacuum and pressure from outside forces the fuel-air mix into the upper part of the cylinder. Next comes the compression stroke, during which both valves remain closed and the piston moves upward, compressing the fuel into an exceedingly small space. Just as the piston rises almost to the top, the tightly compacted charge is ignited by a flame from the spark plug; this results in a very rapid burning (not an explosion) and a consequent expansion that drives the piston back downward. Both valves remain closed, of course, during this power stroke. As the piston nears its bottom maximum and all the energy available has been gained from the fuel combustion, the exhaust valve opens to relieve the pressure and the piston rises in the exhaust stroke. The exhaust valve closes as the piston reaches its top maximum, and the intake valve opens again to permit the charge to enter the cylinder.

To develop a more steady flow of power to the engine crankshaft, more cylinders are added and their power strokes so timed that the push is delivered to a single crankshaft at different intervals. The more cylinders, the more continuous the flow of power.

The lung through which our aircraft engines breathe is the carburetor, a device that mixes the proper amount of air with the correct amount of fuel and atomizes this mixture into its most combustible form—a ratio of slightly more than 13 parts of air to one part of fuel. Any other ratio results in either a rich or a lean mixture. The former condition causes incomplete combustion and some of the unburned fuel is drawn out through the exhaust. The lean mix brings about overheating.

The engine's actual purpose, that of driving the plane, is accomplished by the delivery of the horsepower output to the other half of the power plant—the propeller. The prop screws its way through the air, pulls the plane along, and pushes the air backward in a slip stream, just as the wing gains its lift by deflecting the air through which it moves. Thrust and lift give the airplane its performance, but they must overcome two enemies known as drag and weight. The



MAIN PARTS OF A RADIAL AIRCRAFT ENGINE

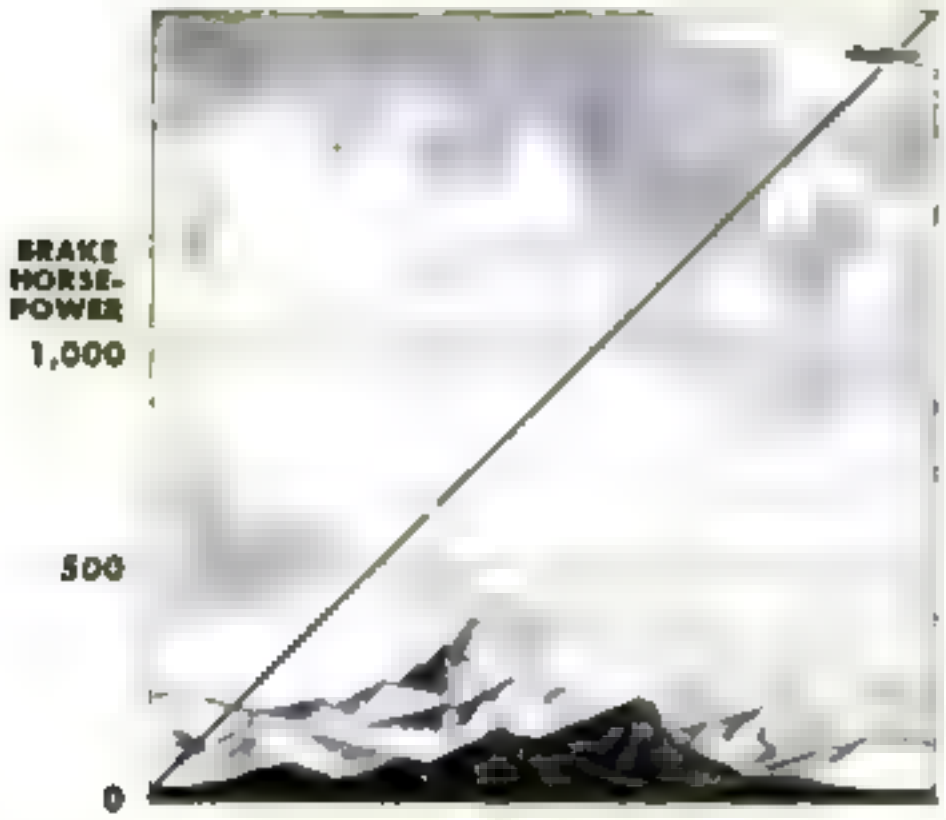
While the modern aviation power plant operates on the same basic principle as the simplest one-lunger, the exacting demands on its performance require it to be the most cleverly designed, most precisely built engine made by man For example, the 14-cylinder radial engine seen in this exploded view packs the power of a locomotive into a space the size of a barrel, and must operate unfalteringly under conditions which no other type of internal-combustion engine is ever called upon to endure

greater the margin by which they overcome these, the lower is the "power loading" and "wing loading" and the better is the airplane's performance. If two bombers are identical in design and weight except for their power plants, the more powerful will be the faster, at all altitudes and under all conditions.

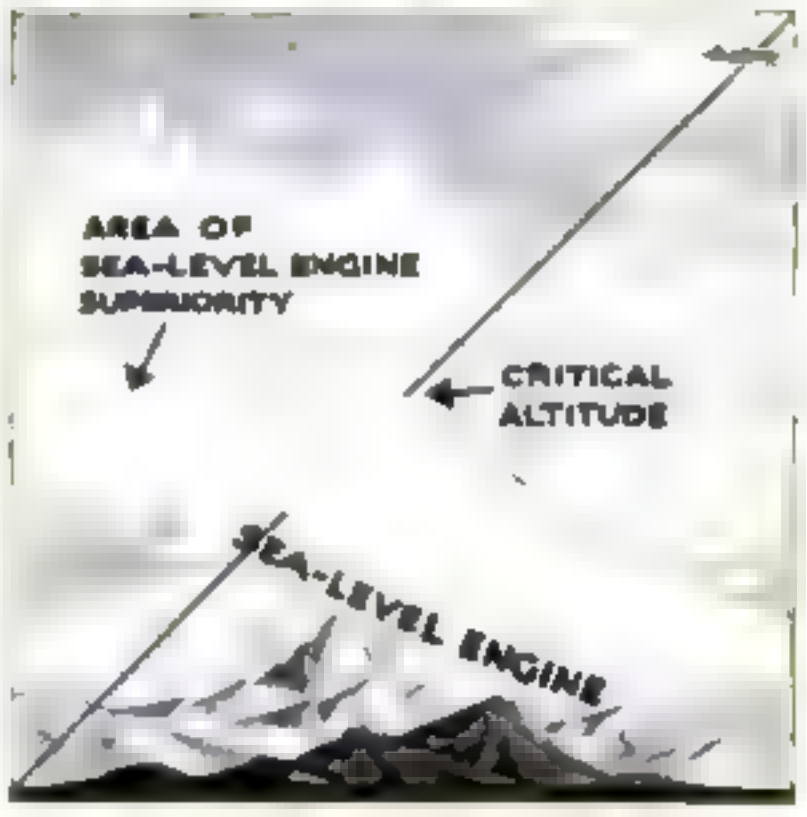
Under ideal conditions, about 86 percent of the engine's power output can be translated into useful thrust by the propeller. But because of certain limitations in the size and rotating speed of props, ideal—or even favorable—conditions are difficult of achievement. Prop and engine must be carefully mated because, for every combination of the two, there is an optimum speed for the prop. On the other hand, the engine's best output is gained at a constant r.p.m., or crankshaft speed, which usually is higher than the propeller's optimum. To make it possible for both the engine and the propeller to turn at their most suitable speeds, a set of reduction gears is built into the nose section of the engine to slow down the prop to between 50 and 75 revolutions to the engine's 100.

Unfortunately for the plane and engine

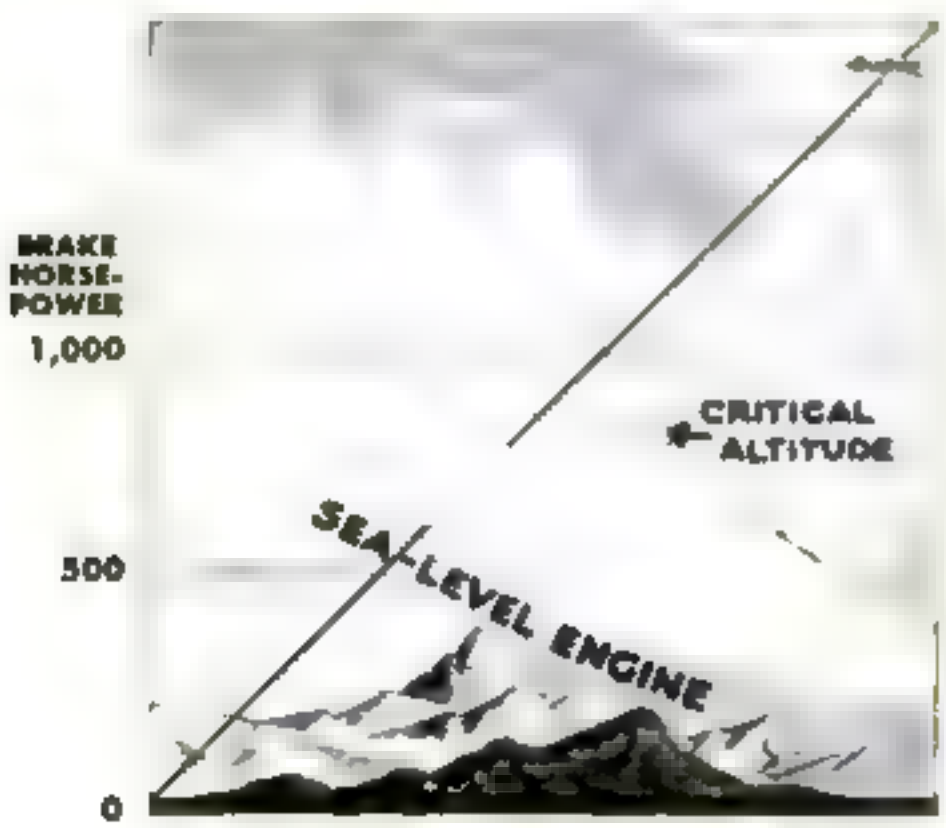
HOW VARIOUS TYPES OF SUPERCHARGERS AFFECT



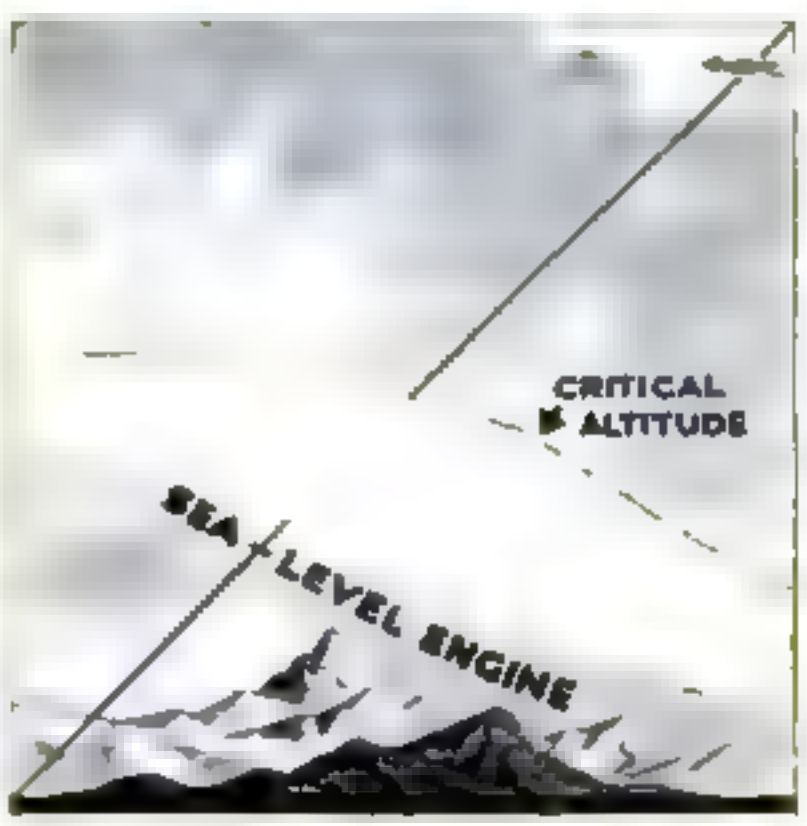
SEA-LEVEL ENGINE has horsepower rating determined for sea-level operation. It loses power steadily as it climbs to higher levels



SINGLE-SPEED, SINGLE-STAGE. Power rises steadily to engine's critical altitude, the level at which it develops maximum power



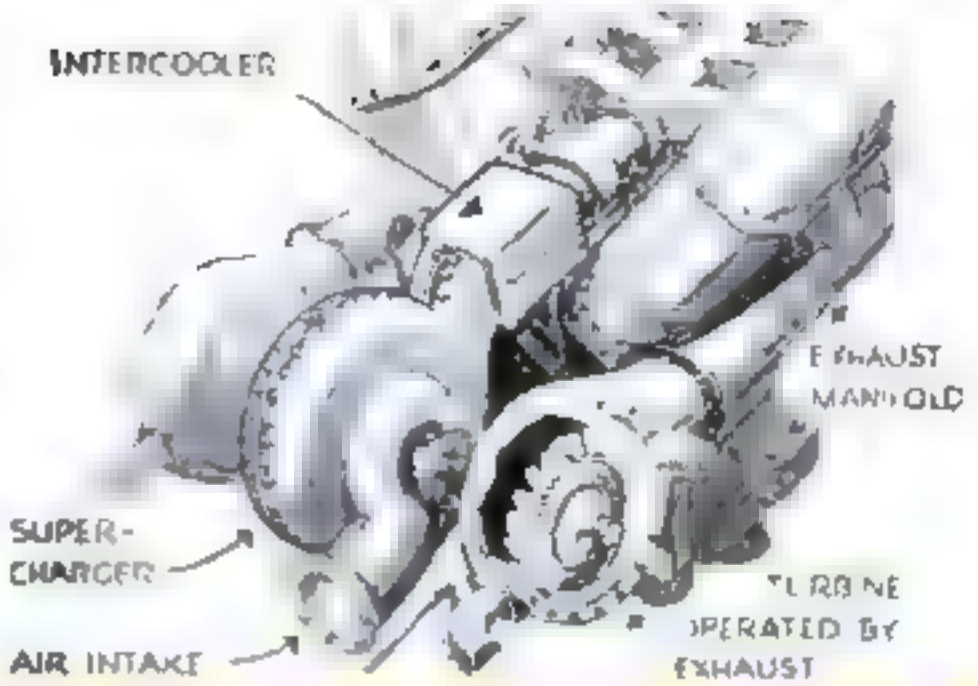
TWO-STAGE (MECHANICAL CLUTCH). Second impeller is cut in manually to raise power curve from trough to critical altitude



TWO-STAGE (HYDRAULIC CLUTCH). This time the second impeller is cut in automatically, giving a more even change in power

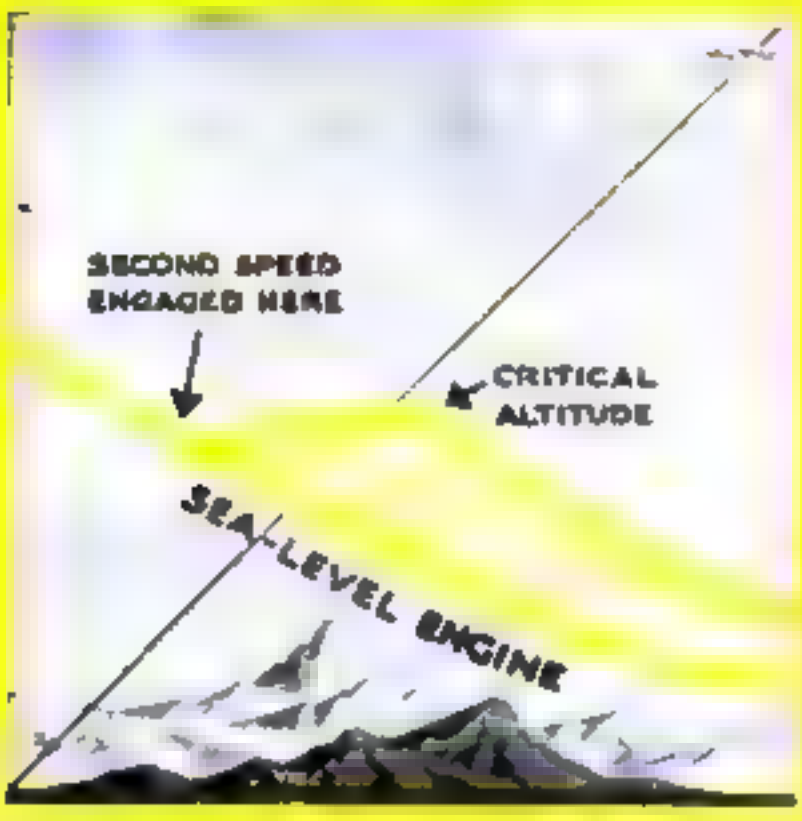
designers, the power plant must do much more than provide this thrust. The whole rear end of the engine is encased in an accessory-section housing which, in turn, is filled with gearing and drives for all sorts of auxiliary equipment. First of all, the engine must feed itself with fuel and oil.

There are one or two fuel pumps in

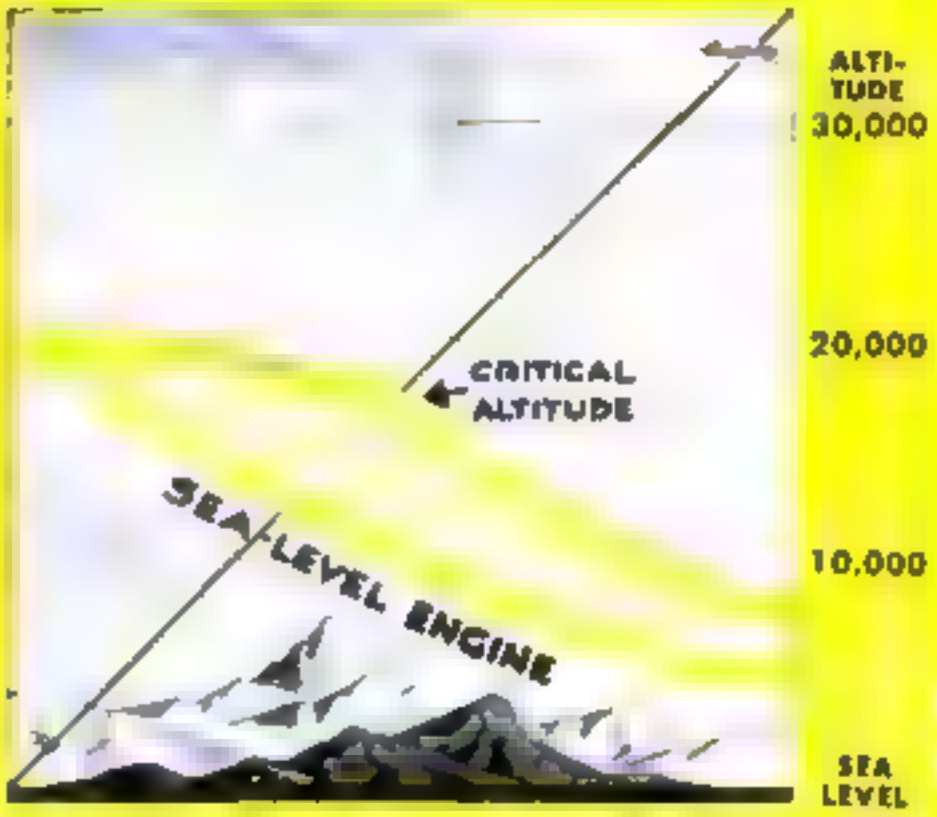


THE TURBO-SUPERCHARGER harnesses engine exhaust gases to drive a turbine which in turn drives an impeller to force air into the engine. The ultimate in superchargers, it does its work without power from the engine

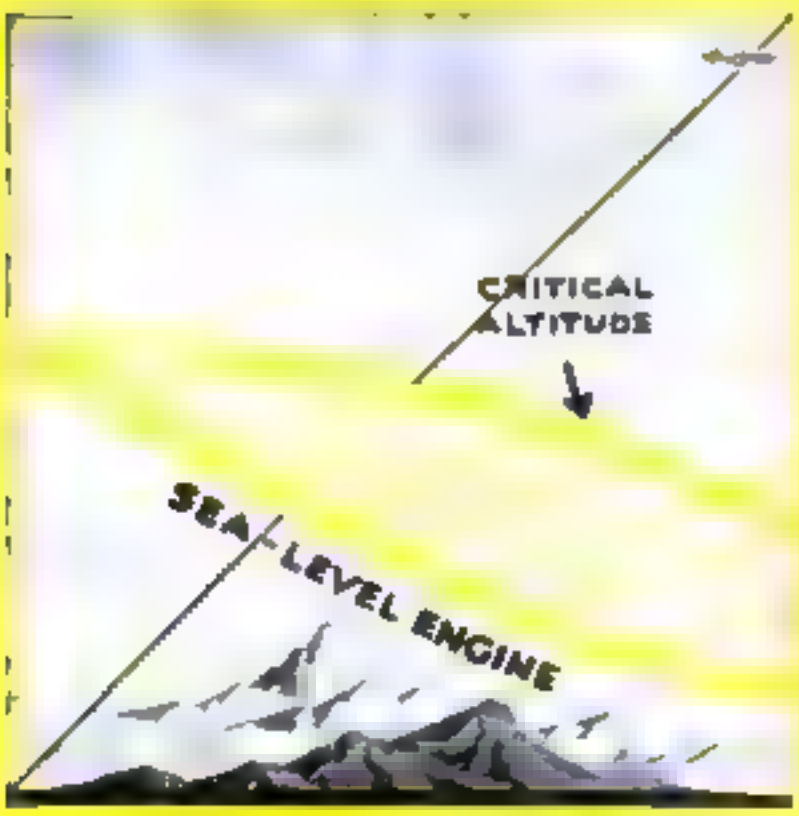
ENGINE'S PERFORMANCE AT DIFFERENT ALTITUDES



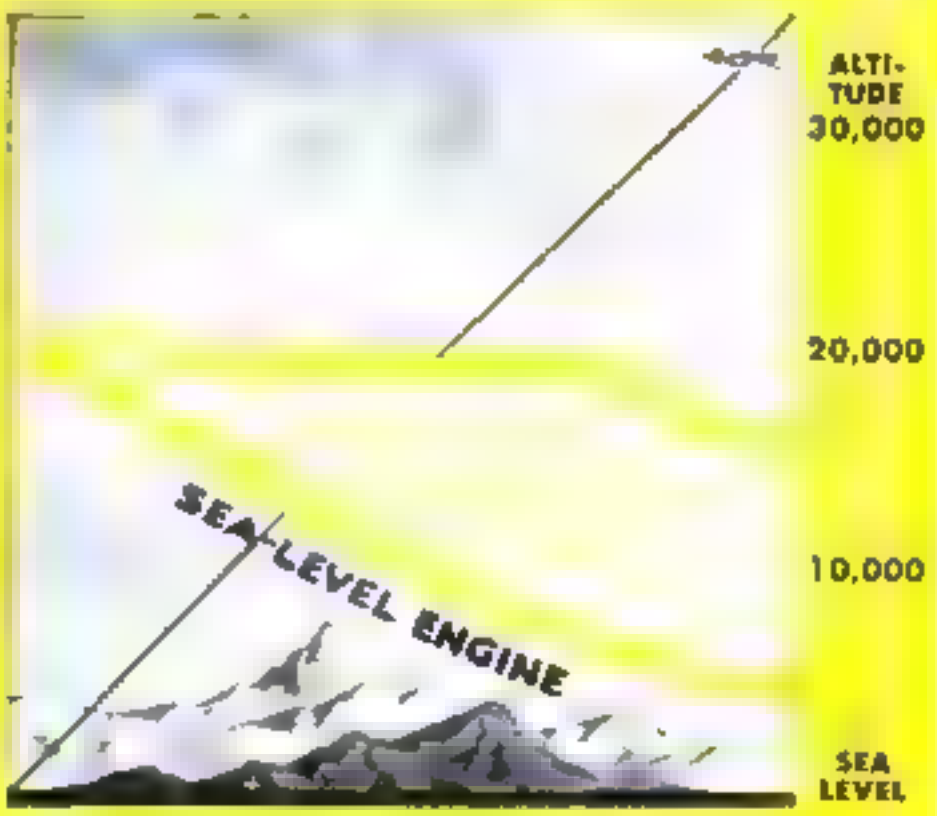
TWO-SPEED, SINGLE-STAGE. Power declines at beginning of climb until the second speed is engaged, rises to critical altitude



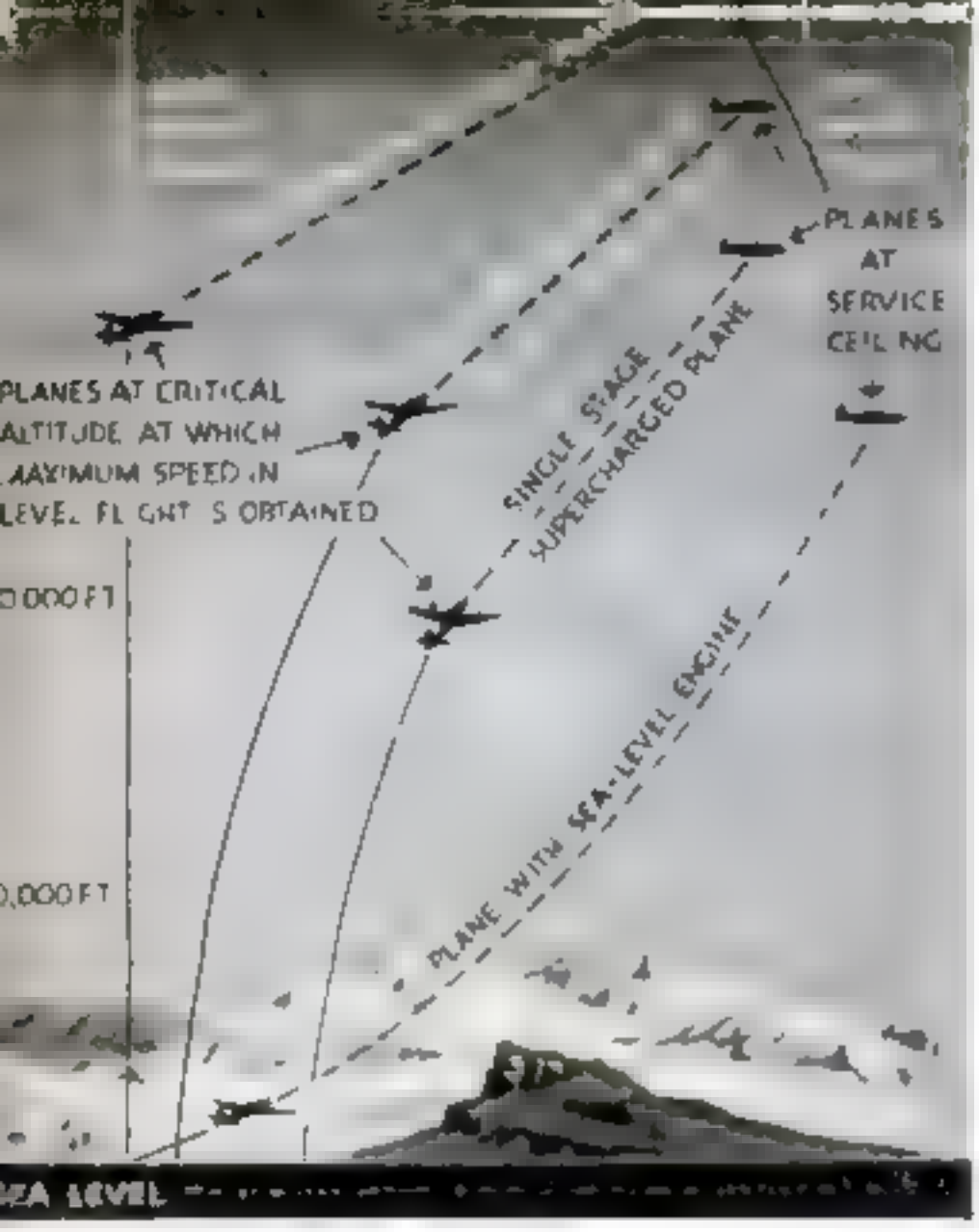
VARIABLE SPEED with hydraulic clutch. Speed of supercharger is increased automatically to maintain engine power as plane climbs



TWO-STAGE HYDRAULIC INTERCOOLING. Cooling of air between supercharger stages gives greater power, higher critical altitude



TURBO SUPERCHARGER, INTERCOOLING. Use of a turbo as second stage of supercharging saves engine power for lifting the plane



CRITICAL ALTITUDE, SERVICE CEILING

The critical altitude of an engine is not to be confused with the service ceiling or critical altitude of the plane itself. This drawing shows the relative heights for comparable planes equipped with same basic engines but varying supercharging

the accessory section whose job it is to flow gasoline from the tanks to the carburetor through the fuel lines at a pressure in the neighborhood of 16 pounds per square inch. High-powered engines drink up fuel faster than you can pour liquid out of a milk bottle, and this pressure must be maintained in order to insure operation under all conditions of flight.

An oil pump is mounted on the engine to provide lubricating pressure. Oil in an aircraft engine not only lubricates all rubbing surfaces to reduce friction but also seals the pistons around the cylinder walls to prevent loss of compression within the cylinder. The engine-driven pump forces the oil from the tanks through the lines and into the oil ports at a pressure of about 70 pounds per square inch. The pump also scavenges run-off oil in the engine sump and returns it to the tank. When a hydraulic-type propeller is used, an additional oil governor pump is used to supply the prop hub mechanism. After receiving its fill of food, the engine must go about the business of digestion, and this is accomplished with the aid of more gadgetry in the rear accessory group.

The ignition of the fuel mixture within the cylinders actually starts with an engine-driven gear that spins the magnetos and distributors. The electric current sparks as it jumps between the points of the plugs and ignites the fuel-air mixture. The movements of the valves, the jumping nostrils through which the engine breathes, are also caused by geared cam rings (in radial engines) or camshafts (in V and in-line-type engines).

In many respects, the engine runs itself, but it also runs just about every other moving part of the plane. The hydraulic system that operates the landing gear, wing flaps, bomb-bay doors, automatic pilot, gun turrets and gun synchro gear, engine-cowling cooling flaps, and other devices is furnished pressure by an engine-driven pump. So is the vacuum system that works various instruments. The electrical system, through an engine-driven generator and dynamotor, furnishes radio power and current for lights, starters, and special equipment for high altitudes (P.S.M., Nov. '41, p. 104). Liquid-cooled engines have additional pumps to circulate the coolant through the jackets and radiators.

Last, but far from least, the engine accessory group has to drive the supercharger, and it is here that most of the power drain goes. All this extra work accounts for the discrepancy between "indicated horsepower" —what is actually delivered by each cylinder —and "brake horsepower"—what is finally delivered to the propeller to result in thrust.

Another interesting aspect of the engine's operation deals with the conditions under which it must power the plane and drive all the essential accessories. Never faltering in its pace or its even rhythm, the double-duty airplane engine is forced to climb through the normal air layer at sea level up to the stratosphere where the air has only a fraction of its sea-level density. In the desert regions, a fighter might take off from a spot having a temperature of 120 degrees F. and, within half an hour, climb to the upper air whose temperature would be 50 or 60 degrees below zero. The engine must function as well while lying on its side as the fighter screws around in a vertical turn as it does in smooth, level flight; it must be equally reliable while standing on its nose in a power dive and while lying on its back in a vertical zoom. These are conditions under which no other kind of internal-combustion engine is forced to operate, or could operate. For this reason, the airplane engine must be more cleverly designed, more carefully assembled and maintained, and built of better materials, than any other type of power plant.

Here is an example of the sort of precision work which makes for this high standard of performance. Mention was made of the reduction gear in the engine's nose that per-

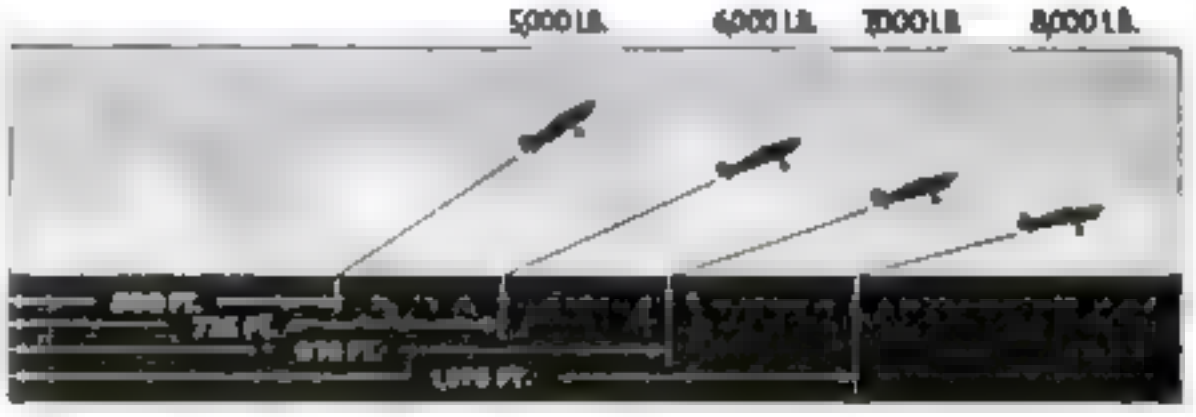
mits engine and propeller to act with better teamwork. A key unit in this set of planetary gears is a set of 20 small pinion gears that, in a Wright Cyclone, connect directly to the prop shaft. A single tooth of one of these pinions has a face with an area smaller than a thumbnail but, with each contact against an adjoining gear tooth, this tiny area transmits 1/20 of the total horsepower output. The gears in the accessory drive turn at terrific speeds—some at almost 10 times crankshaft speed—but they are worked to tolerances ranging from two to three ten-thousandths of an inch. An error as small as .0005 inch, as compared with .0002, can almost double the stresses on a single tooth of a gear. A discrepancy no greater than this can result in the loss of between 10 and 15 horsepower. The smallest engines in military service, such as the Lycomings or Continentals or Franklins that power the Army's grasshopper lightplanes, are built to closer tolerances than the finest auto engine. In Wright and Pratt & Whitney engines which develop 2,000 horsepower or better, parts must be ground and polished with even greater precision.

An automobile engine is broken in by easy running for several hundred miles, simply because the parts are not so carefully ground and must wear themselves into proper lap through friction. This type of engine rarely, if ever, develops its full horsepower. The aircraft engine commences its life, during the very first take-off, at full power and is run at full throttle at some time or other in every flight.

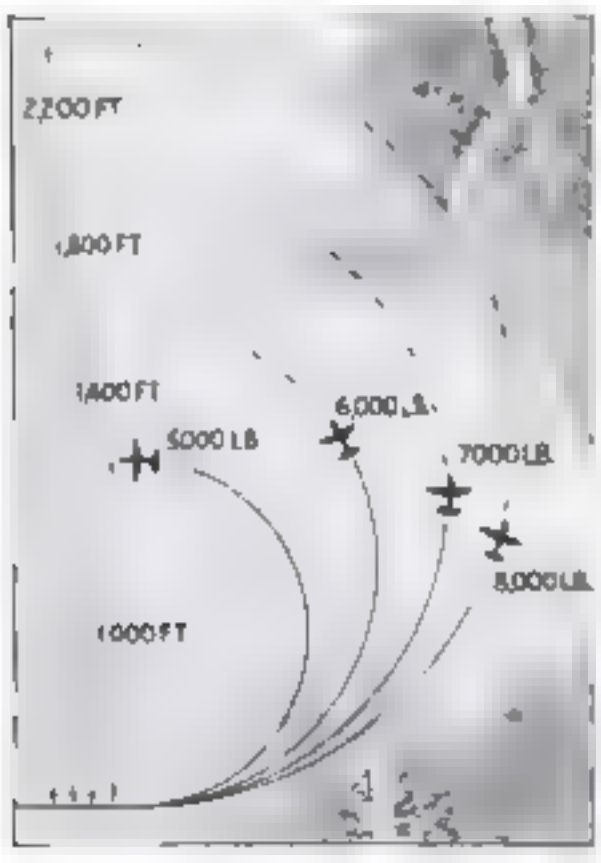
Under all these conditions, the aero engine is influenced in its operation by its teammates, the propeller and supercharger. The latter should be considered not as an auxiliary, but as an actual part of the power plant. Almost all military engines are supercharged, because the power output varies in direct proportion to the amount of air supplied to the cylinders. At sea level, atmospheric pressure enables the fuel-air mixture to enter the cylinder during the intake stroke. As the plane climbs higher, however, the density of the air diminishes and the pressure becomes insufficient to push the required amount of *(Continued on page 204)*

HOW WEIGHT AFFECTS THE PERFORMANCE OF AN AIRPLANE

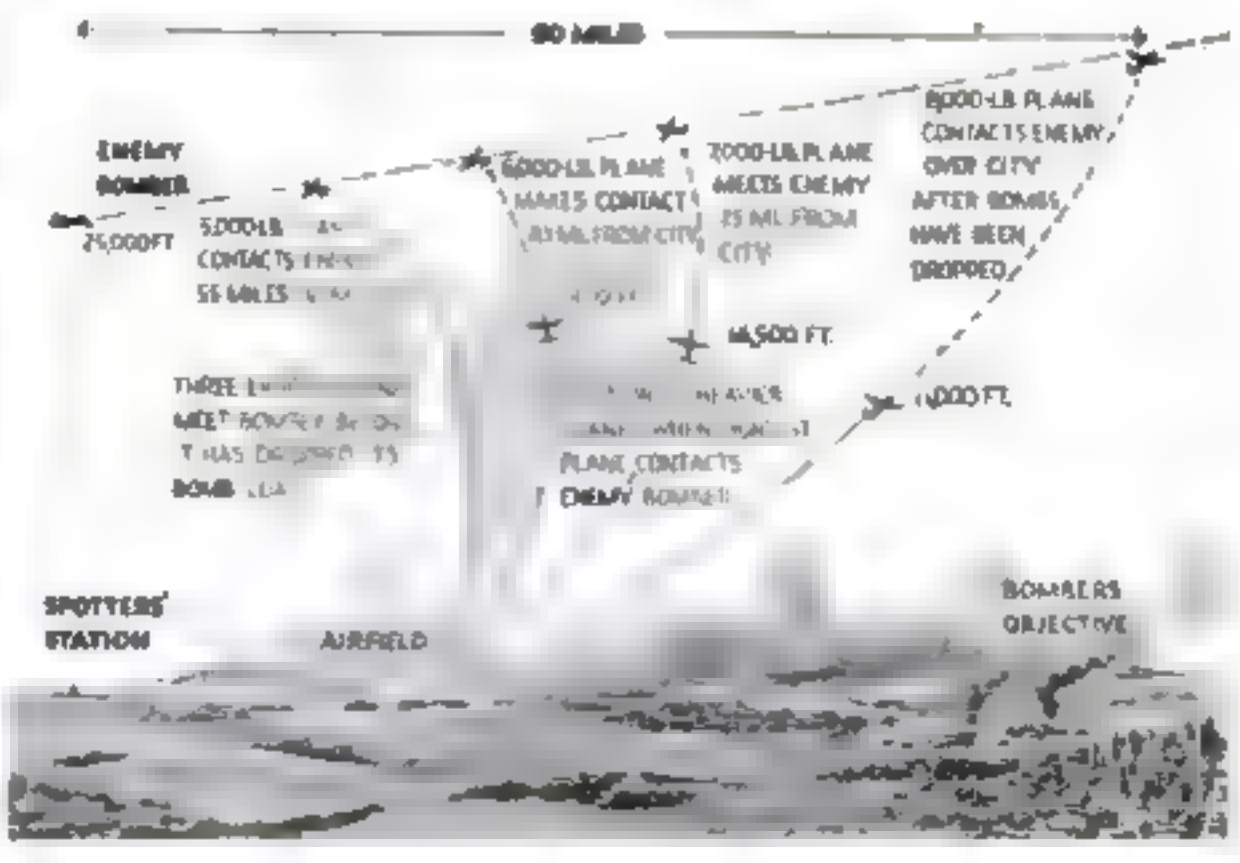
TAKE-OFF. Heavier planes naturally require a longer distance for take-off, as shown in chart (right). This limitation affects the choice of fields for operation



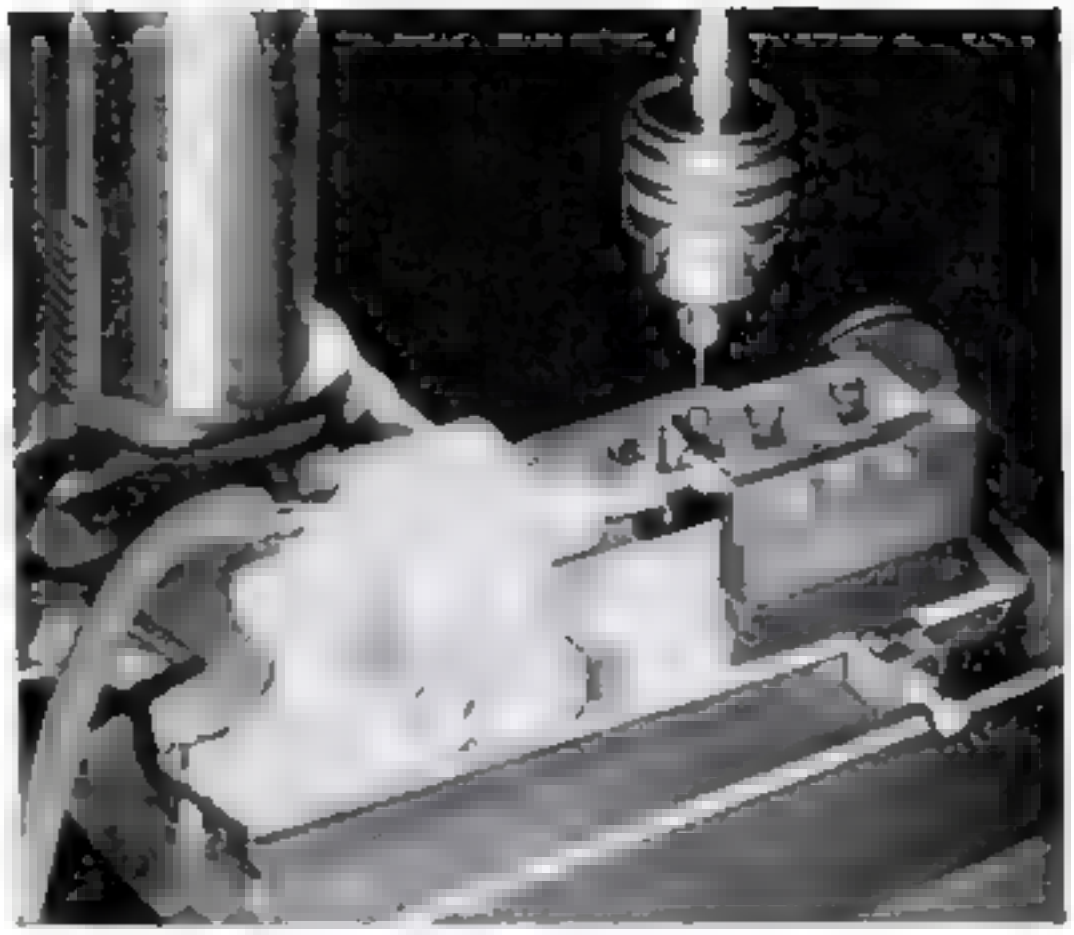
MANEUVERABILITY. Weight affects the plane's ability to turn in any direction. As seen below, an 8 000-pound plane makes more than twice as wide a turn as a 5,000-pound plane. Ships are shown in positions after lightest has made turn



INTERCEPTION calls for a compromise between fast climbing with little fire power or protection, and heavy power that will be too late. In this hypothetical case, the 7,000-pound fighter is the best



NEW Tools



AN AIR CLAMP to replace studs and wing nuts for holding work has been developed by the Mead Specialties Co., of Chicago. Made in a number of models, the clamp has a foot-control button which releases the air pressure behind the holding piston when a new piece of work is to be inserted. The clamp is said to speed some jobs by 400 percent.

BASE

LOWER CRADLE

UPPER CRADLE

A VISE whose swivel cradles and rotating base permit three-way positioning is made by the Universal Vise & Tool Co., of Parma, Mich. The jaw opening has a five-inch range. Wedge locks are torque-tested at 2,000 pounds.

ABRASIVE-CLOTH POINTS spirally wound in a variety of shapes have been brought out by Behr-Manning, of Troy, N. Y., for the finishing of machined steel, aluminum, and magnesium. The points renew their faces by wearing away.

ADJUSTABLE BLADES on each of six different-size tools made by the Robert H. Clark Co., of Los Angeles, permit holes from ⅝" to 4½" in diameter to be cut in wood, metals, and plastics. The smallest of these three-bladed tools cuts from ⅝" to 1⅛"; the largest has a cutting range from 2½" to 4½".

Glare, insufficient light, small type, lack of contrast between paper and print—these are some of the handicaps you put on your eyes when you call upon them to do a day's work. Though wonderfully adaptive, they are as subject to strain as a machine. That is why

Reading Is Your Hardest Job

By WILLIAM P. VOGEL, Jr.

READING is the most difficult and unnatural visual task of the human race. It is one of the high prices man pays for having become civilized. It is hard because it involves resources of the entire body—eyesight, muscles, nerves, energy, and mind. It is not an involuntary job like breathing but a complex job like digging a ditch.

The eyes themselves do much of the work of reading. In a typical eight-hour reading day, they traverse critically two thirds of a mile of type and sweep back over the same distance uncritically to begin a new line. They skip over the page in a series of short jumps, seeing only when they are at rest. If for each jump we were to take a step in walking, an eight-hour reading task would be the equivalent of a march of 33 miles. Even a trained army could make 33 miles only now and then, yet as readers we are

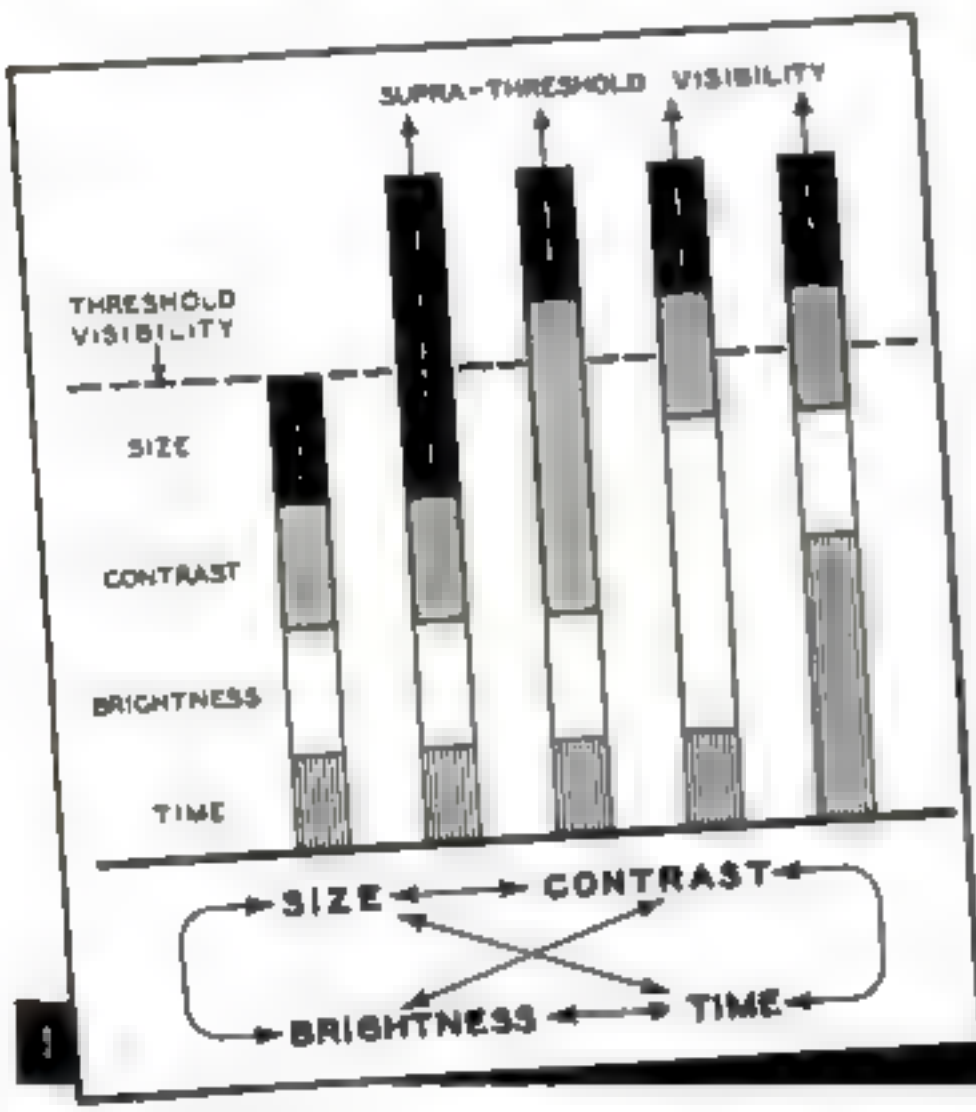
expected to perform its equivalent almost every day.

The eyes have to stay in focus to insure binocular vision. They must track properly to orient themselves on the visual task. Yet only six tiny, sensitive muscles control these important functions. If those muscles fail to work, double vision results, and the eyes jump up and down, wavering from the line of type.

Much experimental work on reading had to be done simply to find out what aspects of it could be measured, and how the measurements had to be made. Dr. Matthew Luckiesh, director of the Lighting Research Laboratory of the General Electric Company, has worked with his associates for more than 30 years at Nela Park, Cleveland, to find out what the important factors of reading are. He concludes that reading is a difficult, complex, critical task of detailed near-vision, which most persons fail absolutely to understand.

Yet today we read more than we ever did, possibly 200 percent more than our fathers did a generation ago. In 1941, in the United States, 140,500,000 copies *of each issue of* daily newspapers and 86,400,000 copies of *each issue* of periodicals were circulated, while 200,000,000 copies of books were printed. With wartime demands for skilled workers, thousands of persons who read little before are now reading to learn new crafts. To doctors and scientists, this is a matter for serious concern, because many people have only the vaguest notion of how to read efficiently, with minimum eyestrain and under conditions that will most effectively safeguard their sight.

The eye is one of the most remarkable of the body's organs; in the reading task it is the center, the very heart, of the human seeing machine, with its 130,000,000 nerve connections telegraphing the sense of sight to the brain. Like other machines, it is subject to the common strains producing fatigue, but it is laggard in giving warning, because it is a marvelously adaptable mechanism. It can work, though far from perfectly, under widely diverse conditions. It can detect at several miles' distance the

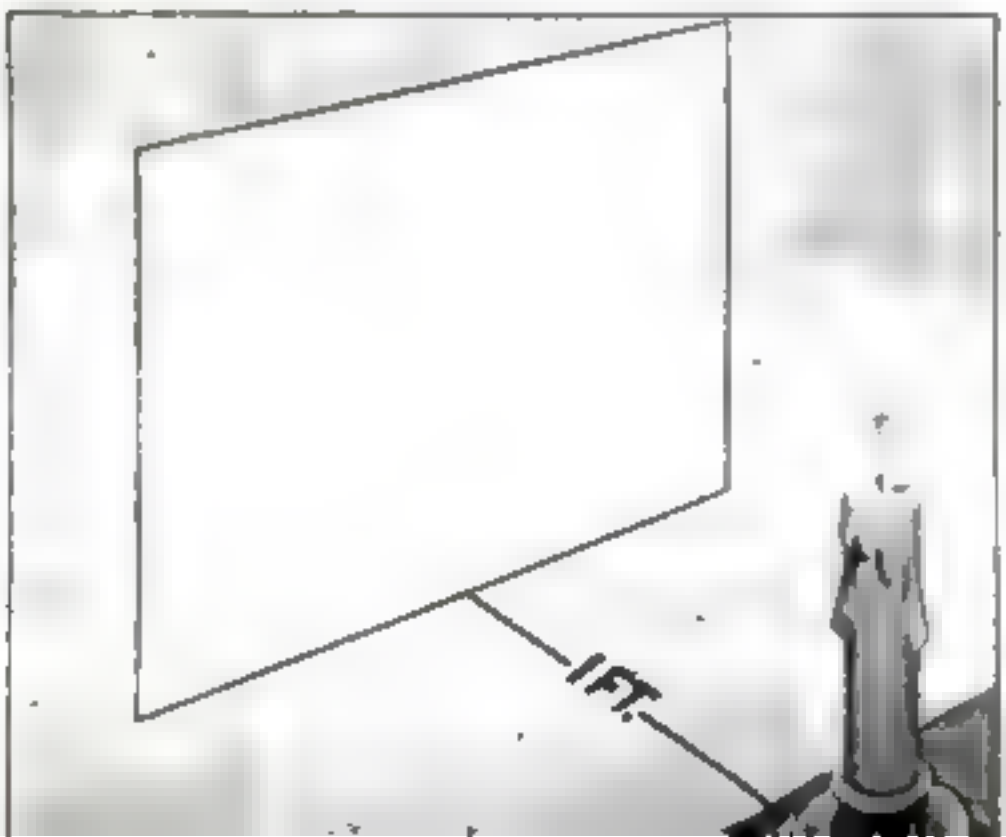


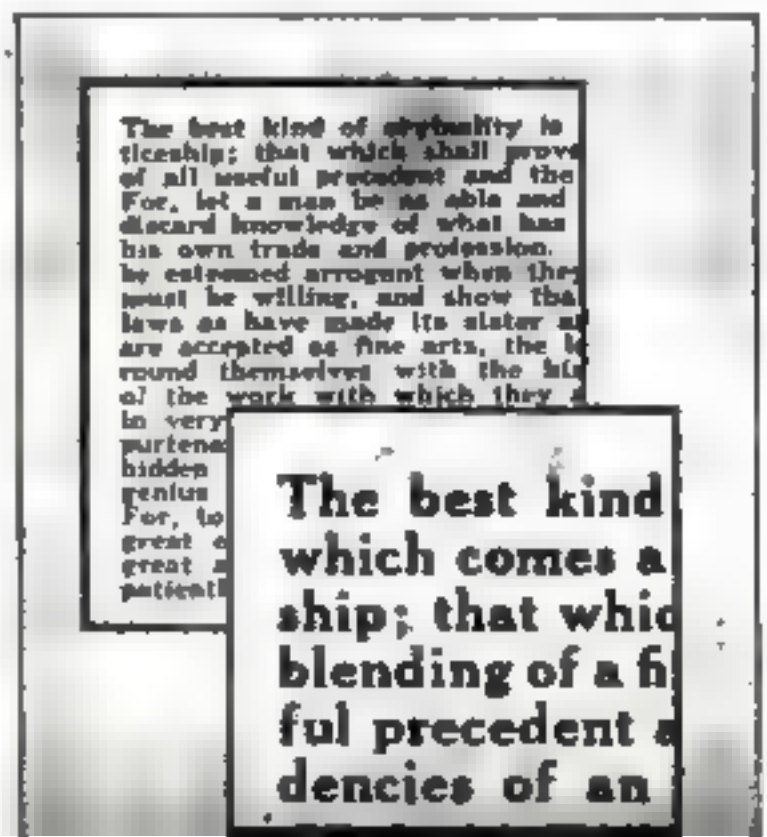
Threshold visibility is the line below which vision is impossible. Augmenting any or all of the factors of vision carries a threshold object over the line to where it can be seen

THESE ARE THE FOUR

BRIGHTNESS This is the most easily controlled and most important. For a severe reading task, illumination should be 100 foot-candles, or 100 times the light of a candle placed one foot away

SIZE is also a big factor, as you can see by contrasting the two type specimens below (five-point and 12-point). Apparent size varies with distance from eyes

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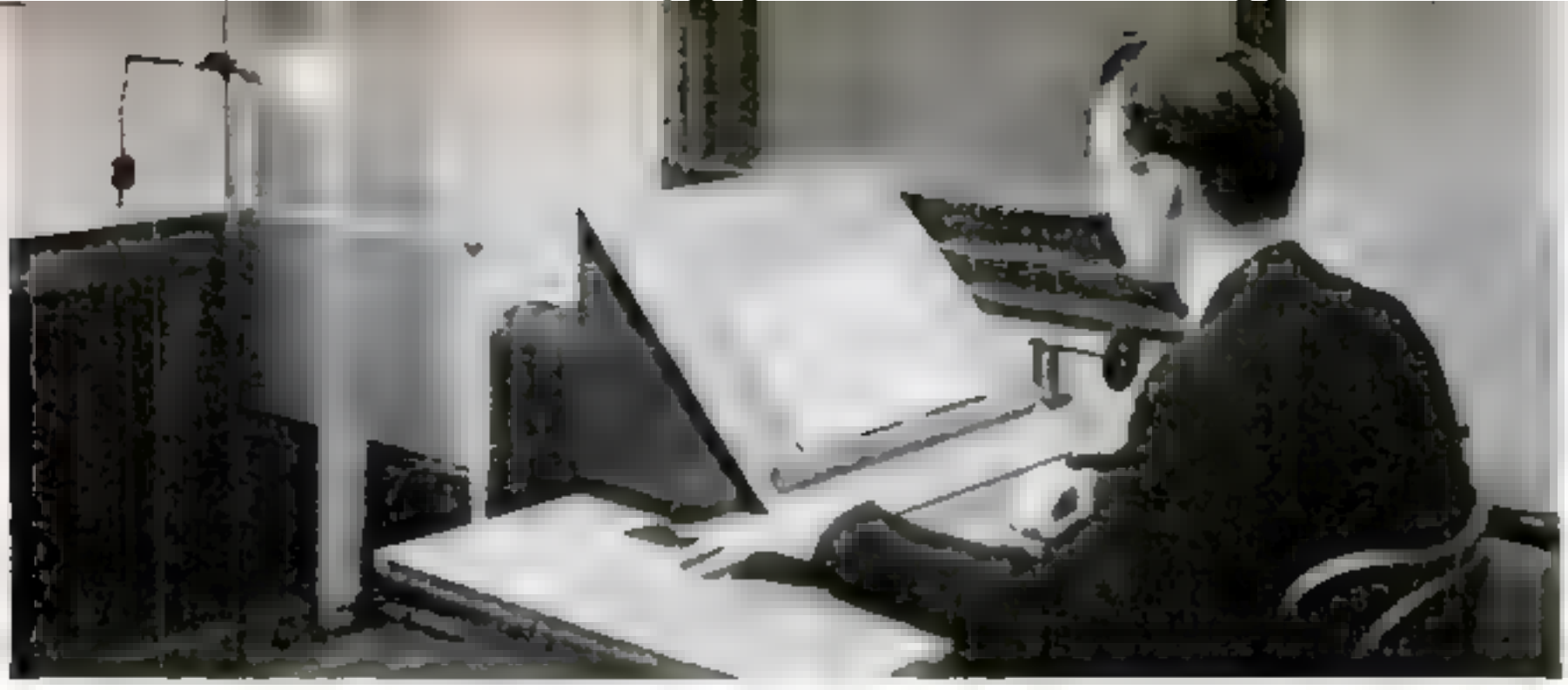


GLARE Reading with a light placed in front of the eyes causes a great increase in nervous tension and promotes eyestrain. The field of a uniformly lighted test sphere (right) is much like that of "a room of infinite extent"

brightness of a candle reflected on a surface; it can endure, for brief instances, light several times brighter than the sun.

Reading, or any other visual task, under the wrong conditions produces eyestrain. Eyestrain affects the power of the six tiny eye muscles and decreases their "convergence reserve"—the muscular power remaining to keep them focused for perfect binocular vision. Eyestrain slows the rate of heart-beat and increases nervous tension. It quickens the rate of involuntary blinking. And in extreme cases, eyestrain produces painful effects which may be symptoms of a permanent impairment of vision.

Dr. Luckiesh and his associates have determined that there are four fundamental factors of vision: brightness, size, contrast, and time. Each has a certain minimum

FUNDAMENTAL FACTORS OF VISION

CONTRAST For efficient reading, paper should be white, ink should be black. Note the vast difference in contrast in the examples that are shown below

TIME Experiments show that an object must usually be within the line of vision for at least .07 second before it can be recognized. Any increase beyond .3 second does not add measurably to the ease of seeing

value—the threshold—below which vision is impossible. To simplify measurements, all the factors in the reading task have been correlated to the foot-candle scale through the use of a visibility meter developed by Dr. Luckiesh and the late Frank K. Moss, of the Lighting Research Laboratory, who did research for the U. S. Army. This instrument makes it possible to equate different visual tasks by treating them as constants but by varying the illumination.

One of the most sensitive criteria in testing the factors is the blink rate. As eyestrain increases, the number of involuntary blinks increases. An hour's reading under the bad light of one foot-candle gives a relative blink rate of 154, whereas at 100 foot-candles it is only 100. The glare from a 50-watt lamp three feet from the eye and 20 degrees above the line of vision gave a blink-rate count of 156. Reading the tiny type that newspapers use for stock-market quotations (six point) gave a count of 148; reading 12-point type gave a count of 100. POPULAR SCIENCE is set in eight-point type with a one-point space between lines. Solid-set type is harder to read than type properly leaded—that is, with white space between the lines—the relative blink rates being 123 and 104.

Brightness is the most universally controllable factor and the most important. It is measured in foot-lamberts. A foot-lambert is the brightness reflected by a perfectly white, perfectly diffuse surface illuminated by one foot-candle. The eye cannot read at all below .1 foot-lambert; it really needs about 100 foot-lamberts to do the job prop-

HOW TO READ YOUR NEWSPAPER CORRECTLY

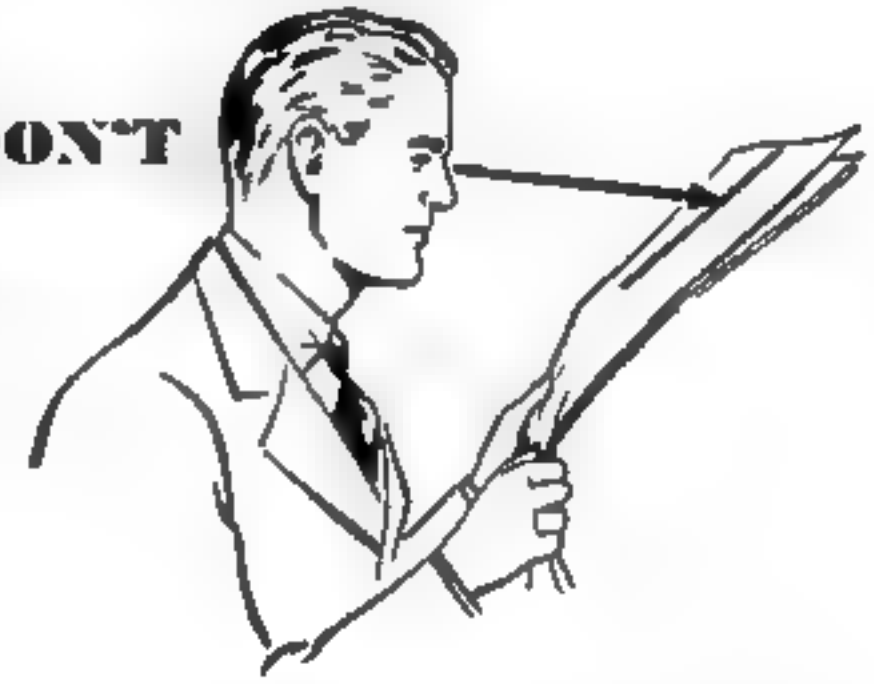
Of the millions of newspaper readers, few realize that they can give their eyes less work if they hold the paper at right angles to the line of sight. The print below is the size of that in the average paper

Mayor Burns referred to this move after adding his anniversary congratulations, thanking the firm's representatives for enlarging the Oneida plant and adding about 300 workmen and their families to the town's population.

The Oneida factory is converted entirely to war work, manufacturing such things as glider wings for the Army, new-type variable-pitch airplane propellers, plywood panels for pontoon bridges and furnishings for Liberty cargo ships.

Sloane's now has an organization of 400 persons working at the shipyards in Wilmington, N. C., installing Sloane products on the Liberty ships.

Specimens of the furnishings going into those ships are on exhi-



But note the difference of the print in the clipping shown here. It is the same as that at left, but has been photographed on a slant to illustrate how foreshortening reduces size

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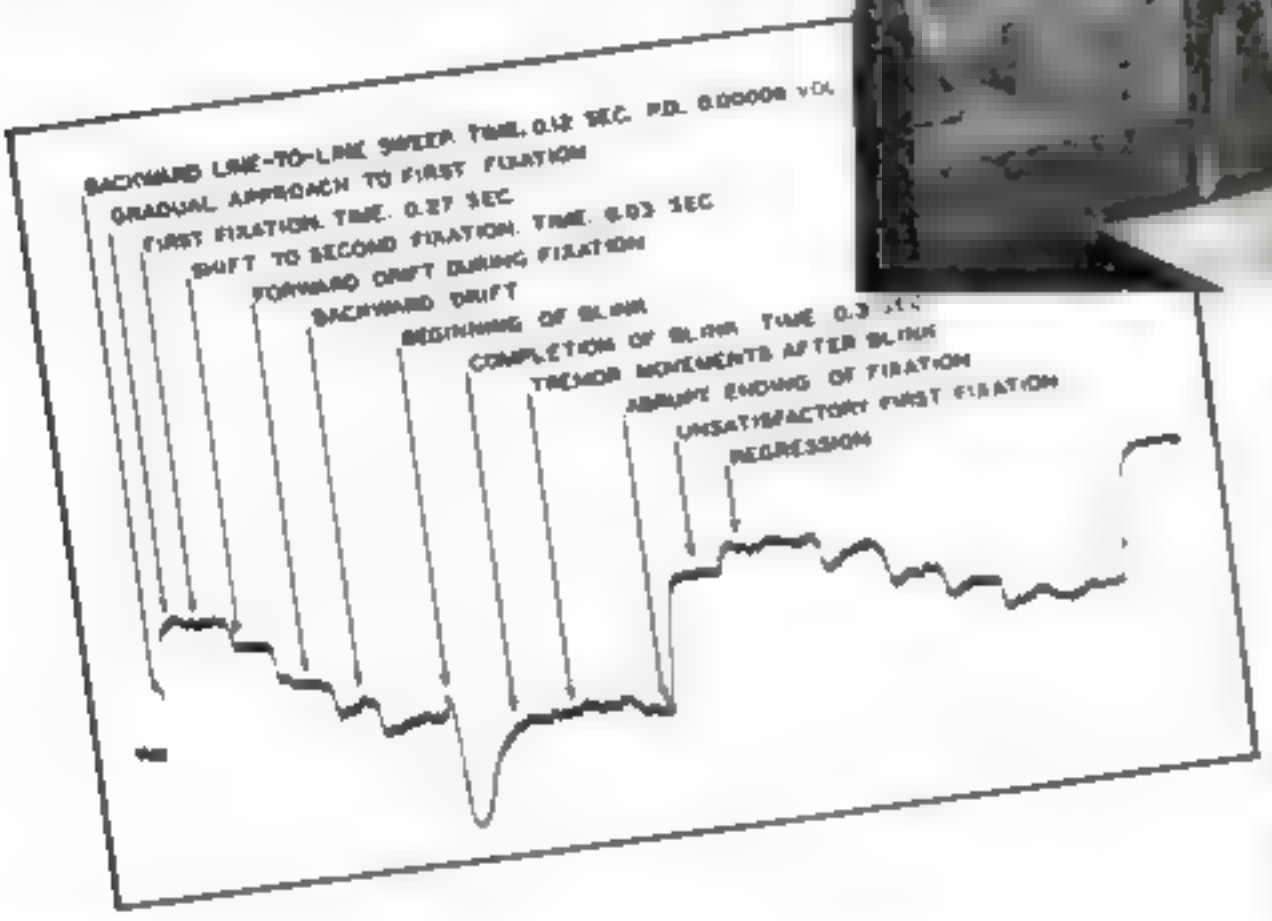
Characteristic eye movements during reading are recorded with the aid of an oscillograph connected to electrodes on the forehead and temple of a subject. The wave-form chart below was obtained while a typical educated adult read two consecutive lines of print



erly. Even at a distance of one foot from a good reading lamp, only about 40 foot-candles fall on the subject matter to be read. Two feet away, the light decreases to 25 foot-candles. For general reading this is not bad, but neither is it good. For severe reading tasks the illumination should be at least 100 foot-candles, and if more can be obtained without glare, so much the better.

The brightness of the surroundings is also a point to be considered. If you read under good light in a dark room, with the light falling only on your reading, the chances are that your eyes will be strained by peripheral distractions. For general purposes, the brightness of the surroundings should be about one third as bright as the reading task.

The threshold value of size has been determined by research on hundreds of subjects to be a simple object subtending a visual angle of 30 seconds of arc—about .002 inch—14 inches away from the pupil. For reading, however, the object must be at least twice as large—one minute of arc, or .0041 inch.

Type size is important. The eye can barely see three-point type. Even today much of the fine print in newspapers is hard to see unless the light is good. Preliminary studies indicate that 12-point is excellent for adult reading purposes. The page should be held at right angles to the line of sight, otherwise foreshortening of the type image takes place, which is the same as reading smaller type.

The lines of type should not be too long, about 13 to 21 picas (about 2⅛ to 3½ inches) generally being considered about right for efficient reading The columns in POPULAR SCIENCE are 15 picas wide (about 2½ inches). Wide margins also seem to reduce fatigue.

Contrast is a more elusive factor to measure. It is easy to think of "perfectly white" paper (reflecting all the light) contrasted with perfectly black ink (reflecting none of the light), but even the whitest paper is really very pale gray. The threshold value of contrast is as low as one percent for simply seeing, but for reading the contrast should be 90 percent.

For best results, white papers and black inks should be used; color tones and deeply tinted stocks tend to make reading harder. The best white papers have diffuse-reflection factors of 80 percent, and the best inks three or four percent. With such materials, the contrast is about 98 percent, almost perfection

The least gloss is the best, otherwise some of the light on the subject will send back to the eye an imperfect mirror image of the light source, which gets in the way of normal, diffuse brightness.

Time is less important. The eye can seldom recognize objects seen for less than .07 second, yet any increase beyond .3 second does not add measurably to the ease of seeing

The advance of technology is taking care of paper, ink, and type size, with a marked improvement already shown in the factors they control. In the long run, light is the big thing. In a generation we have learned to use daylight lamps and fluorescent lighting. Not far in the future is glareless, cold light of even greater diffuseness. Some day science may bring the natural, healthful brightness of the sun to bear directly on the finest, most critical, and most detailed tasks of mankind

Beware Wartime Swindlers!

HERE ARE ELEVEN RACKETS THEY USE TO PRY INTO THE POCKETBOOKS OF THE UNWARY

IDENTIFICATION TAGS are being foisted on housewives by swindlers who glibly explain that the Government requires every citizen to wear one. Anxious to protect the members of their families, housewives have paid $5 apiece for these two-penny trinkets.

By JACK O'BRINE

NEW schemes to swindle the unwary are mushrooming out of this war. Police, public-safety officers, and agents of the FBI report an alarming take by crooks from the average citizen, whose patriotism and fatter pay envelope combine to make him a sucker for flag-waving scoundrels.

Arrests and indictments in increasing numbers attest to the alertness of the authorities. But, unfortunately, thousands of cases escape notice because of the disinclination of swindle victims to report their losses. A survey by POPULAR SCIENCE MONTHLY has exposed some of the more prolific swindles, and they are set forth here as a warning to you.

One of the meanest frauds perpetrated by this wartime crop of sharpers seeks to fleece relatives of dead service men. A letter is addressed to a man whose name has appeared in a published casualty list. Received by the next of kin, it turns out to be a request for the return of an alleged loan, usually $10 or less. The swindle capitalizes on the natural desire of bereaved relatives to assume the financial obligations of the dead. Mothers and widows are the usual victims.

Another racket involves a personal call on families of men in the armed forces. It works like this: Your telephone rings, and a man posing as a friend of your son in camp purrs that Tom has asked him to extend salutations to the family while in town. Of course, he'll be pleased to come to dinner. He arrives and, during the course of the evening, discloses that if you folks really want to make Tom happy you'll send him a camera. The visitor will gladly get it from a dealer friend at half price. He takes the cash and disappears. It's good for $25 to $50.

Fakers, masquerading as volunteer block leaders, are soliciting cash donations from households to purchase air-raid sirens and other equipment for the city. They have a jaunty approach and usually are able to rattle off the names of neighbors who have "contributed." They appeal to the patriotism of their intended victims and to our normal inclination to keep up with the Joneses family. It's good for $20 to $40 a day.

Phony air-raid wardens get another take. They generally carry with them "samples" of a fire extinguisher, which they say the Government requires in every home. They take orders for the extinguishers and other gadgets alleged to be needed for protection against air raids. With the orders, if the victim is easy, these swindlers take full payment in cash "to assure priority." They skip town before complaints reach police headquarters.

There are two other rackets popular with bogus air-raid wardens. One is the selling of "specially treated" sand for extinguishing fires caused by incendiary bombs. The other is to force a first-aid kit on a victim at an

exorbitant price by telling him that he is liable to a fine of as much as $25 if he does not keep one at home.

Bogus repair men, with a glib line to the effect that the Government has ordered citizens to co-operate in an antiwaste program, go from door to door picking up radios, vacuum cleaners, and other appliances. They promise to return the appliances repaired within a couple of days. But they never return. Instead, they peddle the appliances to second-hand dealers and loan shops. It's wise to know your repair man personally.

Crooks posing as real-estate salesmen have made a haul in areas where some of our most important war industries are situated. Because of housing problems, these swindlers find a ready audience among the highly paid war workers. Their technique is the simple one of showing an elaborate architect's drawing of a "bargain" house and collecting a down payment. The house, which is to be rushed to completion, is never built.

Dice and card sharpers are preying on men in war plants. Some of them are actually employed in the factories. Others gather in the neighborhood on the days the workers cash their pay checks. The object is to entice the workers into crooked games in which there is no possible chance of winning. The take is sometimes augmented by the sharpers through sales of phony diamond rings and other jewelry that would appeal to men with money in their pockets.

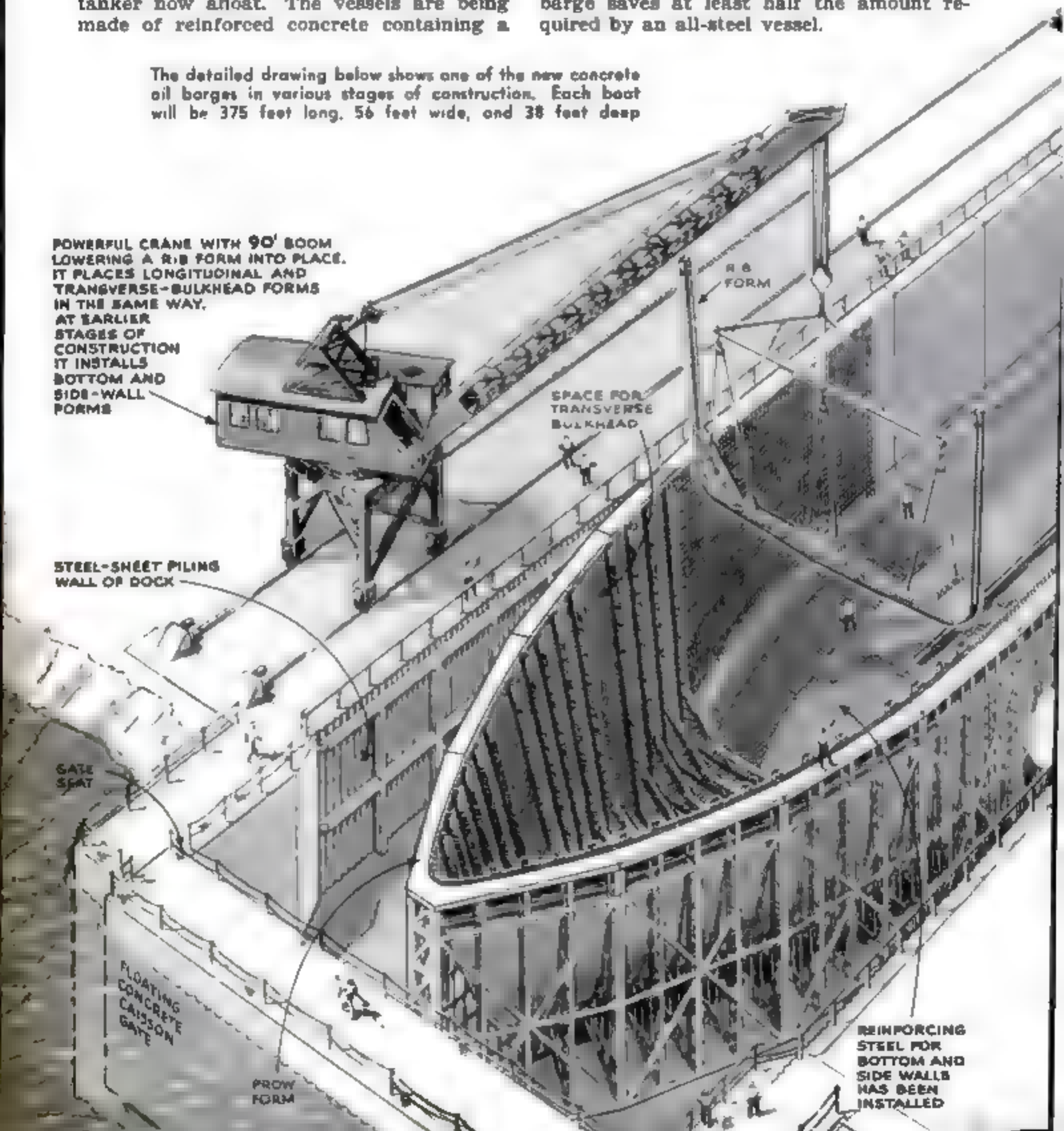
Here's a good rule for escaping the wartime swindlers: Whenever you are asked to part with money under questionable circumstances, demand proper credentials or inquire of responsible organizations or Government agencies.

How POURED SHIPS Are Built

THIN-SHELLED BARGES CAST FROM LIGHT, TOUGH CONCRETE CARRY 50,000 BARRELS OF OIL APIECE BEHIND TOWLINES

TO TRANSPORT oil abroad or from one American port to another, a fleet of concrete barges is now under construction for the U. S. Maritime Commission. Carrying no propulsion machinery, the barges will be moved, either singly or in twos or threes, by towing. Each barge has a capacity of 50,000 barrels, which means that a single tow can carry as much oil as the largest tanker now afloat. The vessels are being made of reinforced concrete containing a clay known as Haydite, which adds to its strength while reducing its weight. So tough is this new composition that these 14,000-ton boats require only a five-inch shell across the bottom and up the sides to a height of 18 feet. Constantly increasing prefabrication of steel units is helping to speed up production. Although a large amount of reinforcing steel is needed, each barge saves at least half the amount required by an all-steel vessel.

The detailed drawing below shows one of the new concrete oil barges in various stages of construction. Each boat will be 375 feet long, 56 feet wide, and 38 feet deep



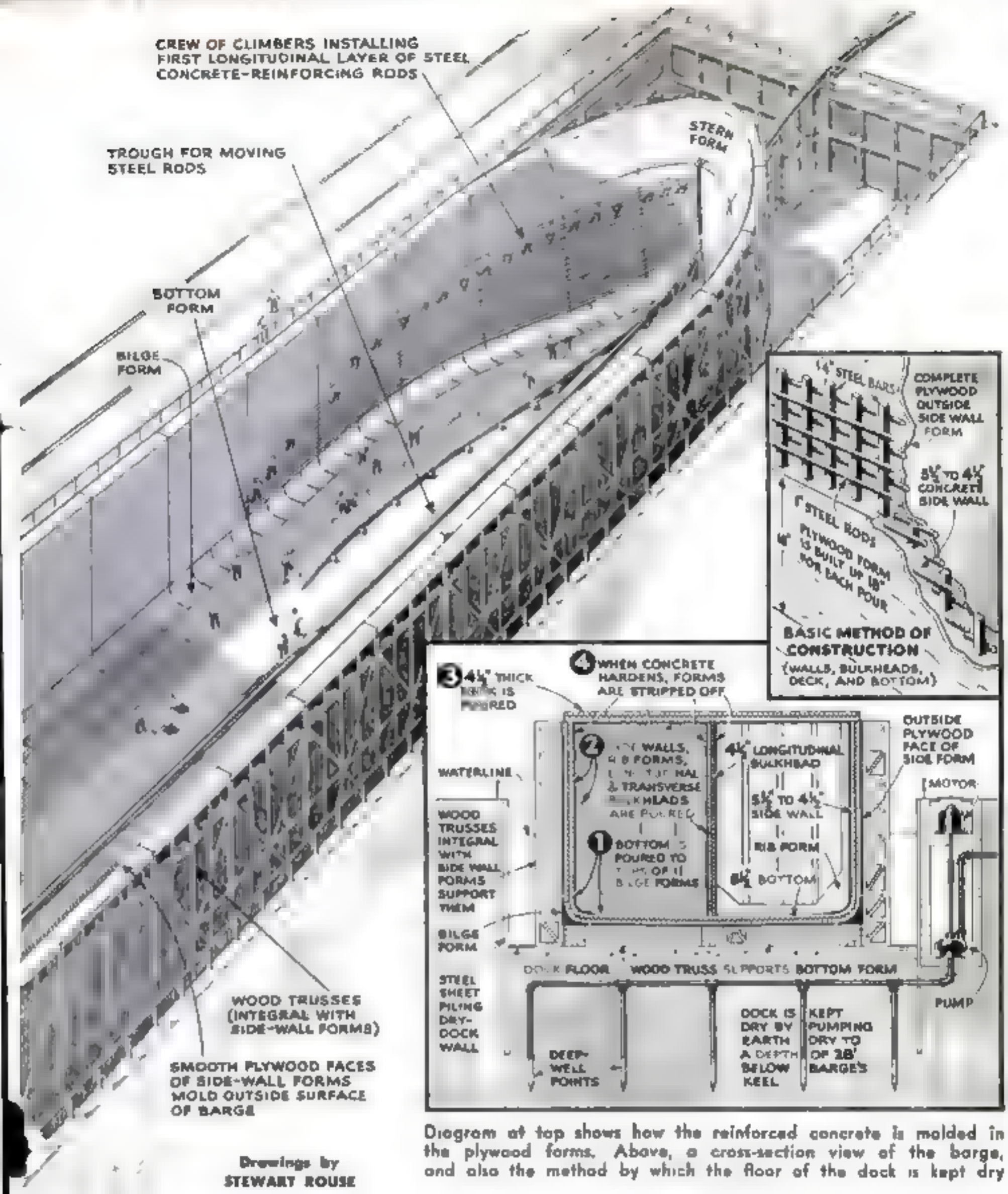


Diagram at top shows how the reinforced concrete is molded in the plywood forms. Above, a cross-section view of the barge, and also the method by which the floor of the dock is kept dry

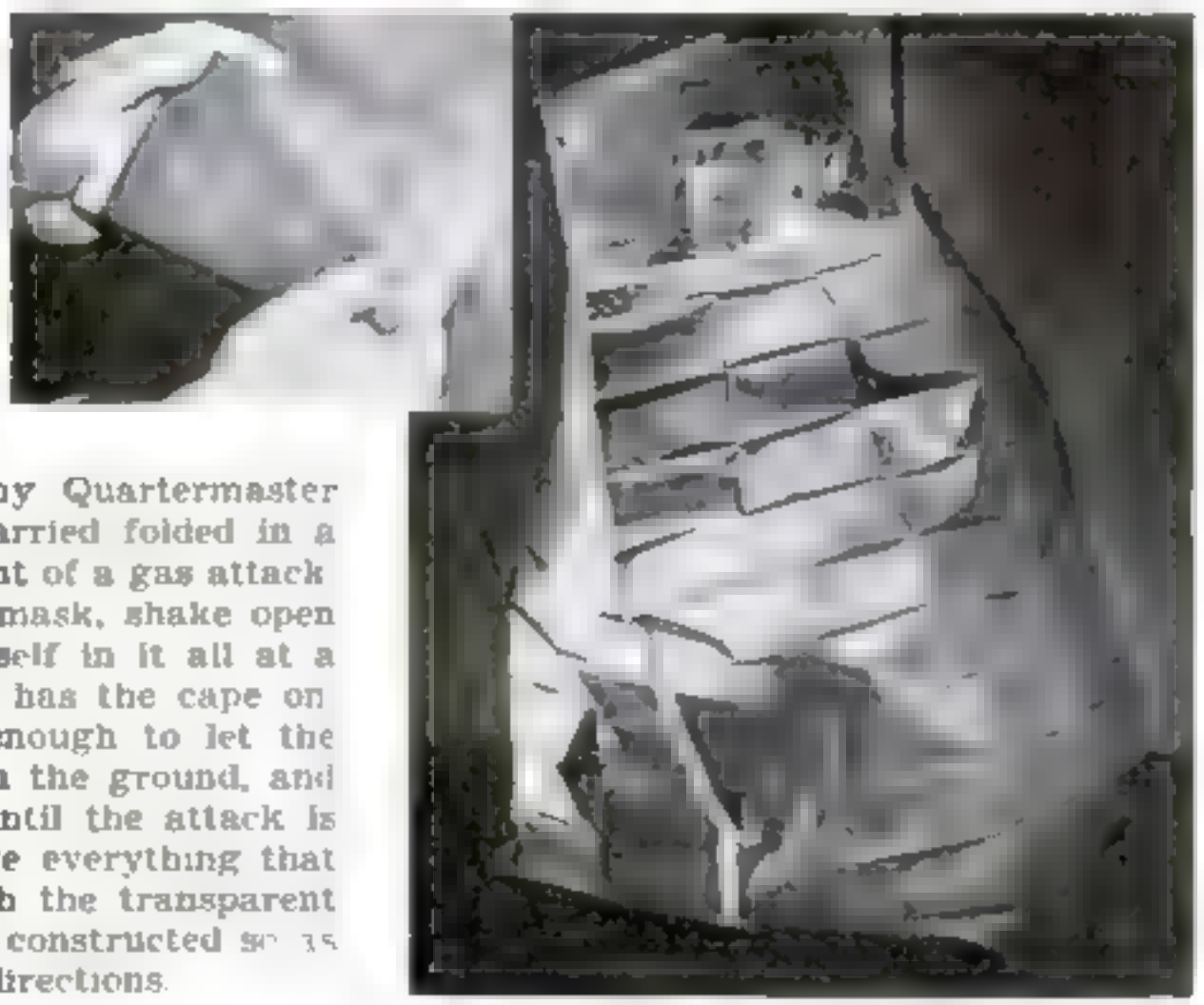
Drawings by
STEWART ROUSE

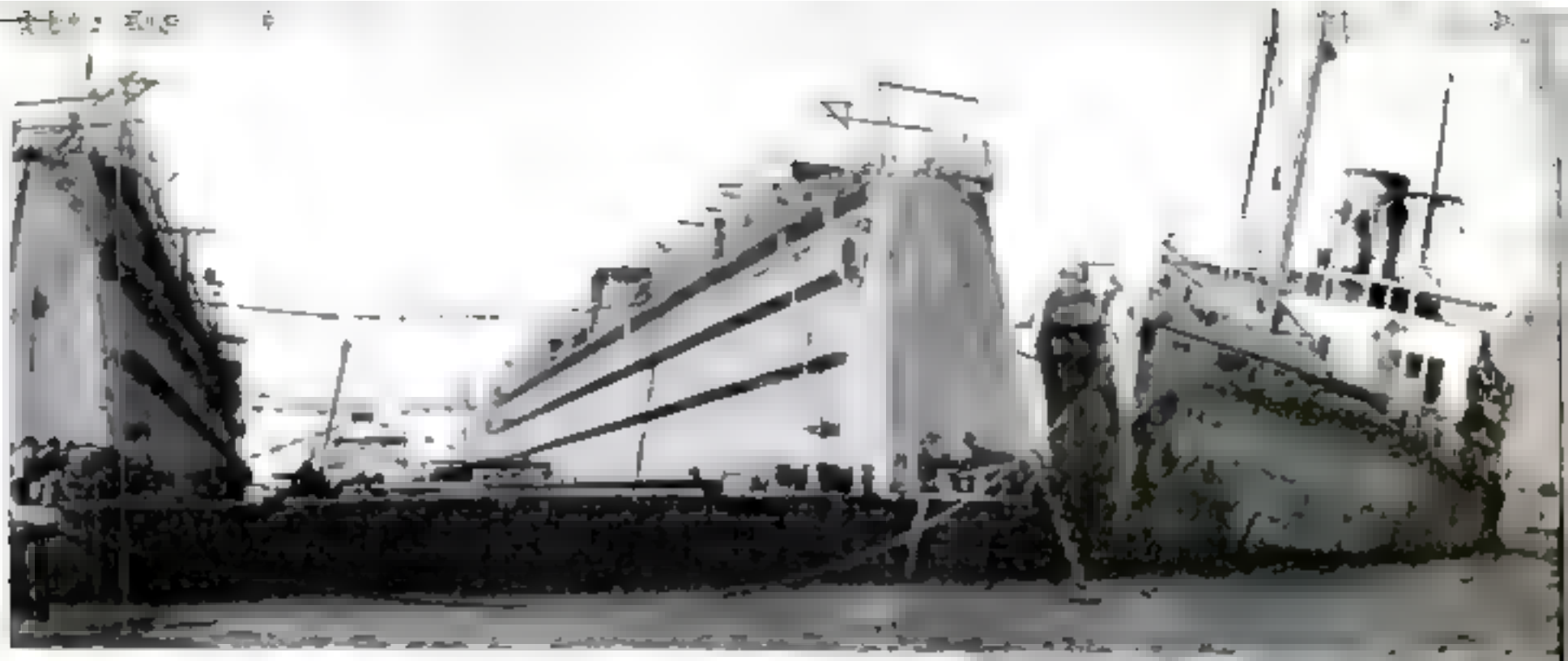
Two of the boats built by Concrete Ship Constructors in their shipyard at National City, Calif.

SECTIONAL SKIS that can be "broken down" into two pieces to make a more compact load have been developed for military ski units by the McCord Company, of Minneapolis, Minn. Putting the skis together or taking them apart can be done in a matter of seconds by means of a simple foolproof device, which can be either locked or unlocked in one easy motion. The new skis are said to be just as strong and maneuverable as the conventional type.

A FIRE BLANKET, said to be 100-percent flame resistant, is being manufactured as a wrap-around to be used in extinguishing fire in workers' clothing. Flexible and specially knit, the blanket comes in a cloth container, which can be easily carried or hung in an accessible spot. It is made by the C. Walker Jones Company, of East Germantown, Philadelphia, Pa., and is expected to gain a wide acceptance in those industrial plants where workers have to handle inflammable materials.

GASPROOF CAPES are being issued to U. S. troops as an added protection in the event the enemy should attempt to repeat one of his tricks of the first World War —a surprise attack with a vesicant, such as mustard gas. Developed by the U. S. Army Quartermaster department, the cape is carried folded in a handy package. In the event of a gas attack a soldier can don his gas mask, shake open the cape, and enclose himself in it all at a moment's notice. Once he has the cape on he merely crouches low enough to let the bottom of the cape rest on the ground, and remains in that position until the attack is over. He is able to observe everything that goes on about him through the transparent hood of the cape, which is constructed so as to permit visibility in all directions.





This huge floating dry dock was recovered by U. S. Navy engineers from the harbor bottom at Massaua, in the former Italian colony of Eritrea. Besides serving Allied ships, it is reconditioning Italian vessels raised in the successful salvage job at Massaua

One of the many vessels waiting to be raised. These boats were sunk by the Italians to keep them from falling into British hands. Most have now been salvaged—for use against the Axis

Capt. Edward Ellsberg, the noted American authority on naval salvaging, directs native workers

Italian Ships to Fight the Axis

WHAT is considered to be one of the miracles of naval salvage has just been completed in the great Eritrean harbor of Massaua, in Italian East Africa. Freighters, tankers, liners, and even a huge floating dry dock capable of handling a 10,000-ton ship, have been raised from the mud of Massaua harbor where they were scuttled by the Italians in 1941 to prevent their capture by British forces. The British were stumped by the salvage problem, and said it couldn't be done. So U. S. Navy engineers took a crack at it. Under the direction of Capt. Edward Ellsberg, the noted American submarine-salvage expert, they not only raised the giant dry dock but are now using it to recondition the many boats which they hauled out of the surrounding waters. Operations on this tremendous undertaking required the use of expert American divers, colossal pontoons, and floating cranes. Manpower for the job was supplied by friendly natives. One of the machines most used was the underwater torch for cutting steel invented by Captain Ellsberg, designer of the Navy's submarine-salvage system.

An expert American diver jokes with his handlers before going down to remove unexploded demolition bombs and mines from the sunken ships. One vessel was found to be full of torpedo warheads

AUTOS

Starting Your Car

By RALPH ROGERS

WHEN Admiral Byrd sailed home from his first antarctic expedition, he left his plane, the *Stars and Stripes*, in a house of frozen snow blocks. Five years later, he found it buried under a mountain of ice and snow that took a week to remove. After the ice was chipped and melted from the engine, hot oil was run through; then the engine was turned over. It started on the first attempt.

If his car gets reasonable care, a motorist should have no trouble starting in any kind of weather. Hard starting and nonstarting can often be attributed to little things that a periodic inspection would reveal for correction. Fortunately, most can be found without special equipment.

Go over the connections at the ammeter, ignition switch, coil, and distributor, and tighten or clean any found loose or corroded. If the low-tension wire insulation is cracked or worn through, replace it. Be sure the low-tension ground connection is tight. Examine the ignition switch for loose, corroded, or burned contacts, and install a new switch if a repair cannot be made. Replace an ammeter that will not function.

Examine the high-tension cables for cracked, oil-soaked, wet, chafed, or worn insulation. Be sure the cable from the coil to the distributor is seated snugly in its terminals. If you remove the ignition coil, establish a good ground contact between it and its mounting when you replace it. This must also be done with the distributor.

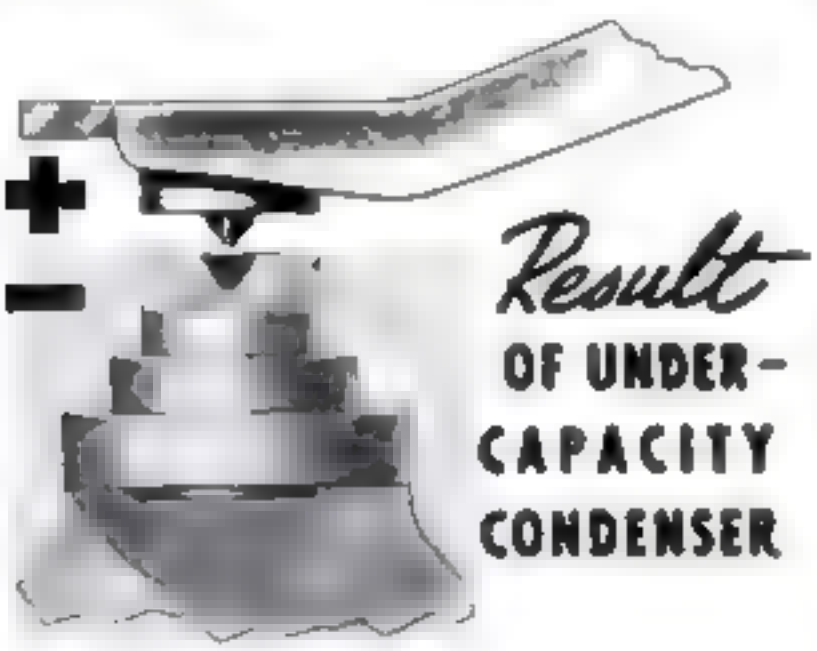
Spark plugs may become fouled because of an excessively rich carburetor mixture, worn piston rings, loose fitting in the cylinder head, or damaged or ineffective plug gaskets. Replace any plug that has

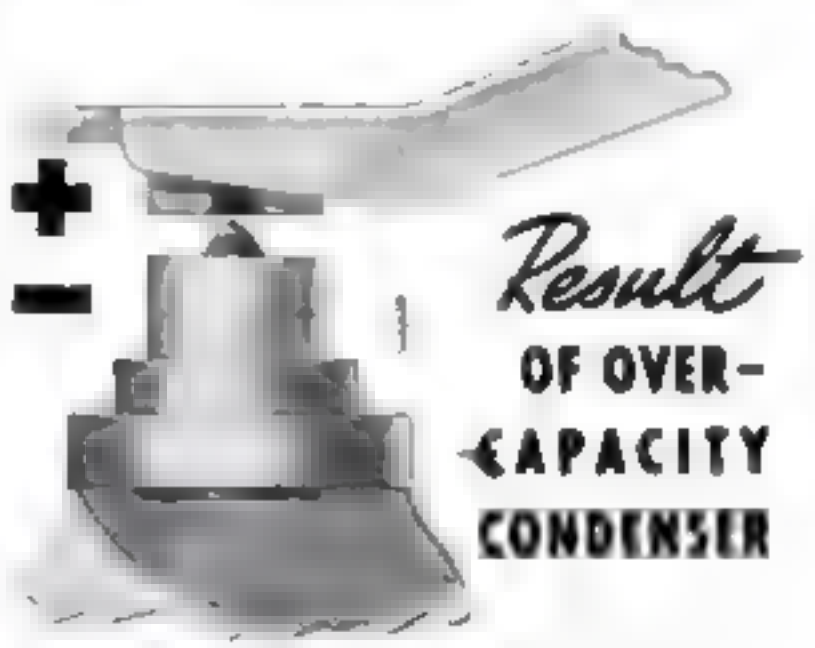
Oil on contact-point surfaces causes them to arc and burn rapidly. The arrow points to a smudge from oil or crankcase vapors in the distributor

Material transferred from one point to the other causes pitting. Serious trouble may develop if abnormal operation unbalances an ignition system

If pitting continues to be serious even after new points have been installed, a condenser of a different capacity will usually remove the cause

At left, below, the build-up is on the positive point, and a higher-capacity condenser is needed, while at right the situation is just the opposite





SHOULD Be Easy

burned or cracked insulation, being sure to use one with the proper heat range. For normal operation, follow the manufacturer's recommendations; otherwise install the plug in the next higher or lower range.

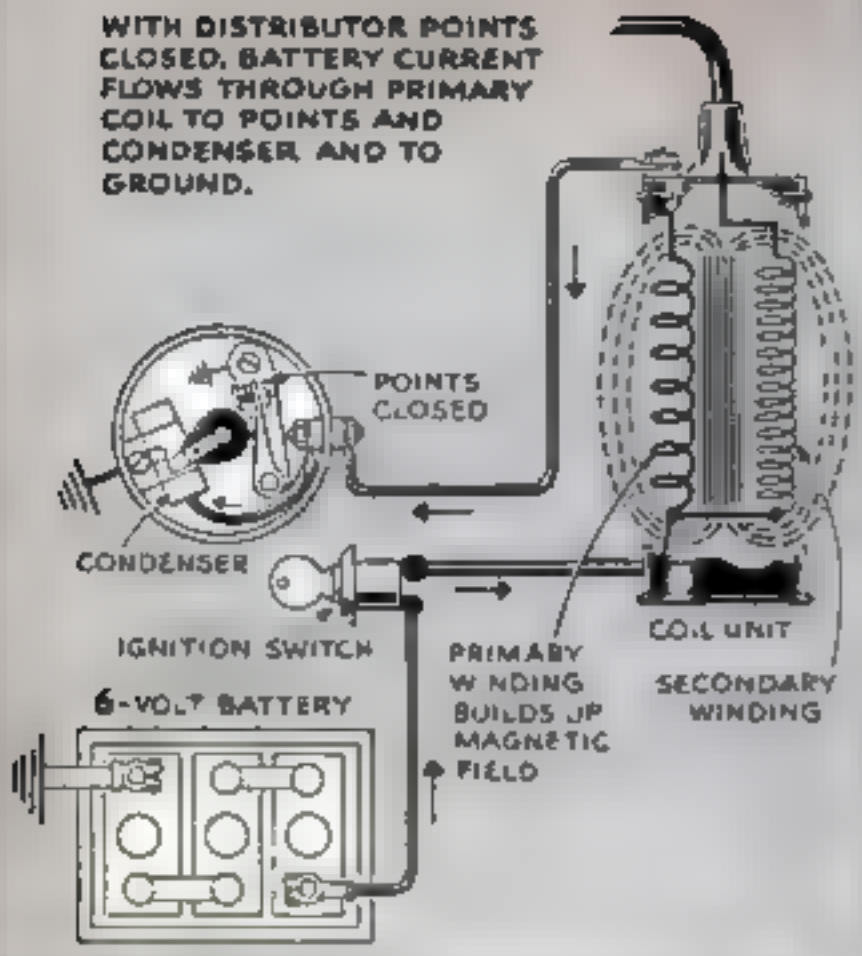
A "cold" plug has a shorter insulator than a "hot" plug to allow the heat to travel faster to the cylinder head. A plug that is too hot will develop small blisters and heat the insulator tip so much that the gas will fire before the spark occurs; one too cold will collect carbon and oil on its insulator and will eventually develop a short circuit that will cut out the spark. The plugs are correct if the insulators are slightly brown or tan and fairly clean.

Spark-plug gaps set too wide will cause hard starting and poor top-speed performance; those set too close, poor idling and low-speed operation. New gaskets are always needed with new plugs, and they must be the correct ones, for they have to carry the heat away. Plugs should make a good contact, but too much pressure may change the gaps. A half turn after contact with the gasket should be sufficient. The outsides should be cleaned frequently.

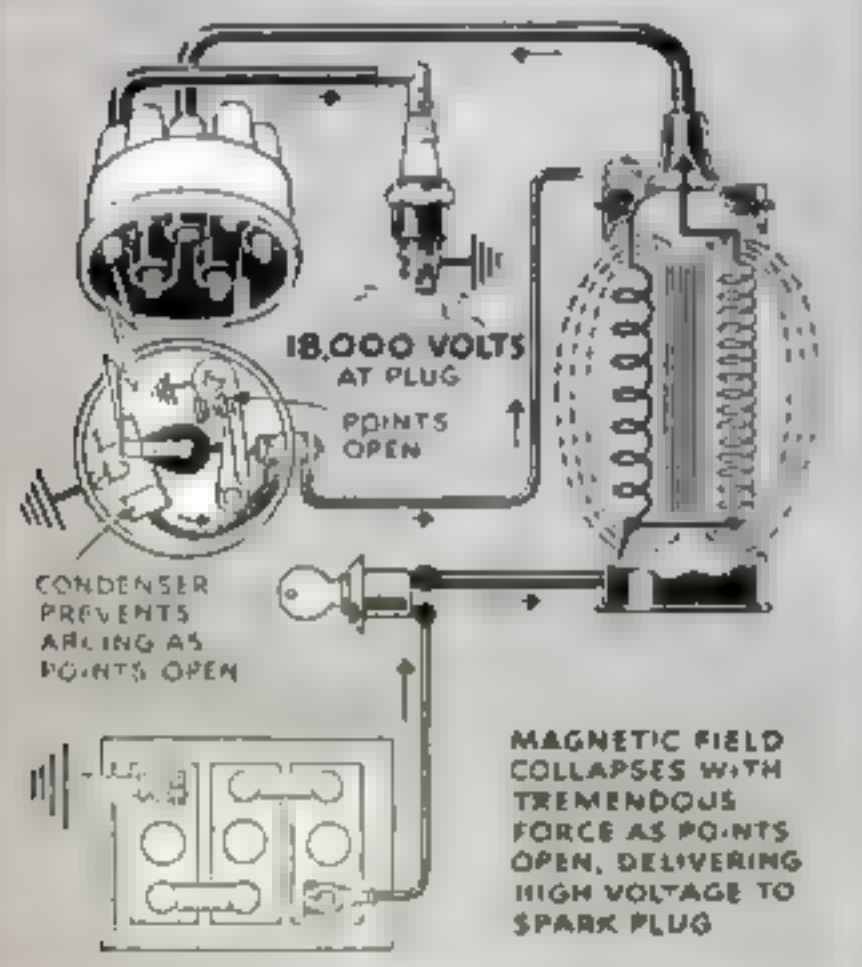
Remove the distributor cap and clean it thoroughly; then look for cracks and bent, loose, or badly burned inserts. Be sure the rotor contact (center terminal) is not broken or missing, or the rotor spring broken, loose, or bent.

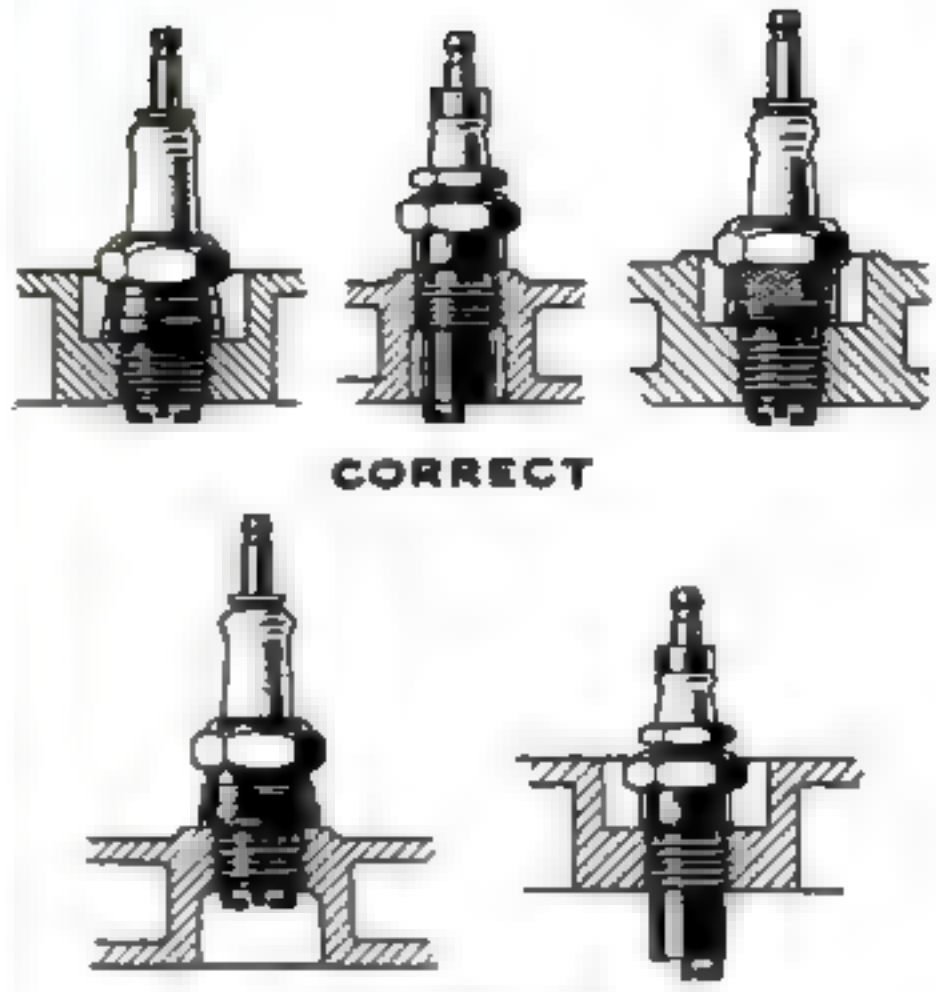
Inspect the contact points for excessive wear, pitting, or burning. If they are dirty, clean them with a few strokes of a contact file or stone. Do not try to remove all traces of pits—merely remove the high spots.

Poor connections in the condenser or a loose condenser lead may cause points to burn. If the former is the case, replace the condenser. An excessive flow of current



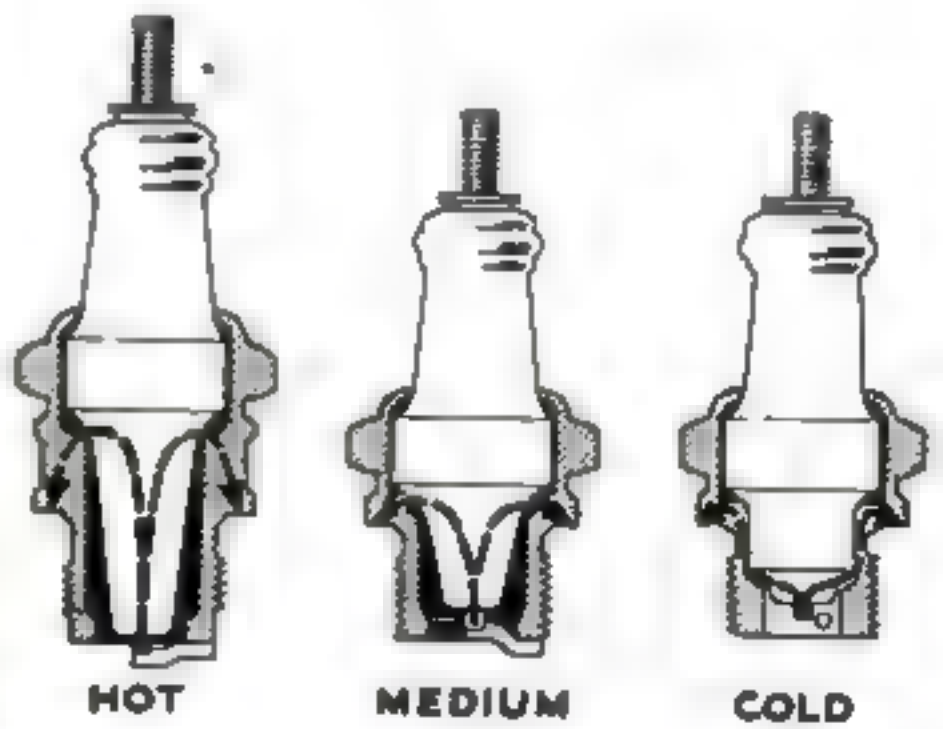
IGNITION SYSTEM. How a typical system functions is shown below, with the distributor points open, and above, with the points closed





SPARK PLUGS should always be chosen to fit the thickness of the cylinder head in which they are to be used. The drawings above show right and wrong types used on cylinder heads of varying thicknesses

HEAT RANGE. The distance heat must travel from the center electrode of a spark plug to the cylinder head (shown by arrows below) determines heat range



through point gaps set too close will cause rapid burning as with high voltage resulting from poor regulator setting. Badly pitted points are usually caused by an overcapacity or undercapacity condenser. If the build-up of point material is on the negative contact, the condenser is probably overcapacity; if on the positive contact, the opposite is likely

Other things to look for in a distributor are: (1) a breaker gap that is too wide; (2) a weak or broken breaker-arm spring; (3) a breaker arm grounded because of a worn or broken insulating bushing or a loose or worn rubbing block; (4) loose breaker-plate terminal posts or loose or broken pigtail lead wires, (5) incorrect ignition timing; and (6) a worn distributor shaft or a loose or worn bushing or bearing.

Of course, a low battery will give trouble, but if the cause of its condition is not obvious, it should be tracked down and remedied by a competent auto electrician. If the starting motor is at fault, it should be repaired by an expert. Periodic servicing of the carburetor and air cleaner will also help to keep starting easy. Hard starting is a signal of coming trouble.

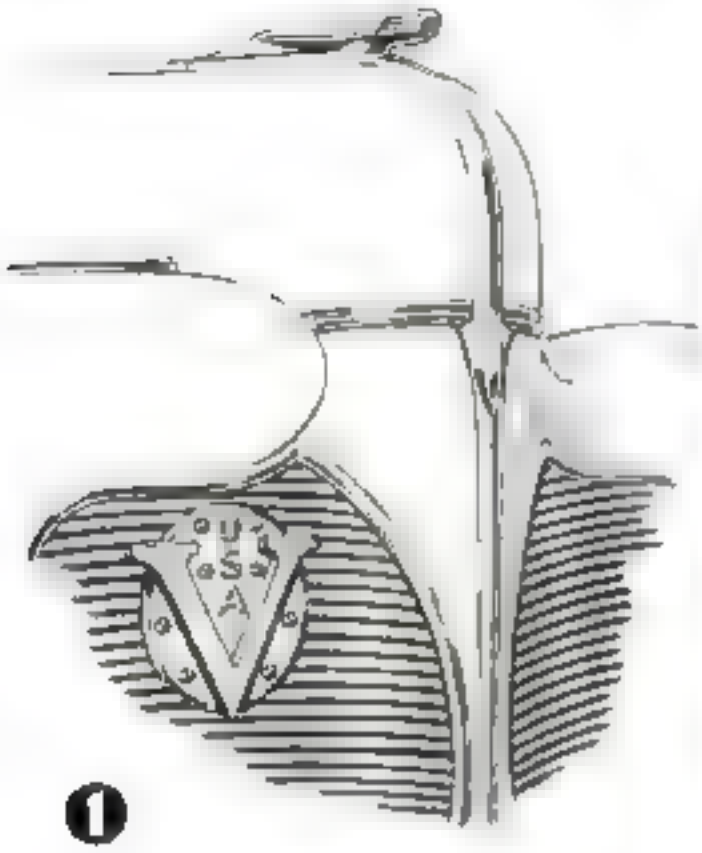
AUTO Ideas

COMPARATIVE AIR-LOSS TESTS of the tires on a car show up punctures and slow leaks before they cause flats. Air pressure in all four tires is checked *before* air is added. A tire that has lost much more than the others probably has a leak and should be inspected. Tests such as at right show that even a nail may for some time cause only an unsuspected slow leak.

STORING YOUR CAR for the duration? If so, an auto lay-up kit that contains materials for protecting the vital parts of your car, including the radiator, battery, starter, gas tank, and transmission will come in handy. Contents of the kit are shown at the left.

TRANSPORTATION OF WAR WORKERS to and from plants has proved an acute problem, which the two vehicles shown here are helping to solve. The one above was built from an ordinary sedan. This was cut into two sections, and a 6 extension was added between the two parts. Fifteen passengers ride to work in this sedan-bus, which has a large compartment in the rear for storage of work clothes, tools, and the like, uses a minimum of critical materials, and requires little more gasoline than did the original car. The "before" and "after" photos at the right show how an automobile-transport trailer has been converted into a coach trailer that will seat 100 war workers comfortably In converting the transport trailer, the superstructure was removed and a new steel framework built on the lower structure. The result is a unit that is comparable to many standard busses both in comfort and effic.ncy.

USEFUL AUTO HINTS



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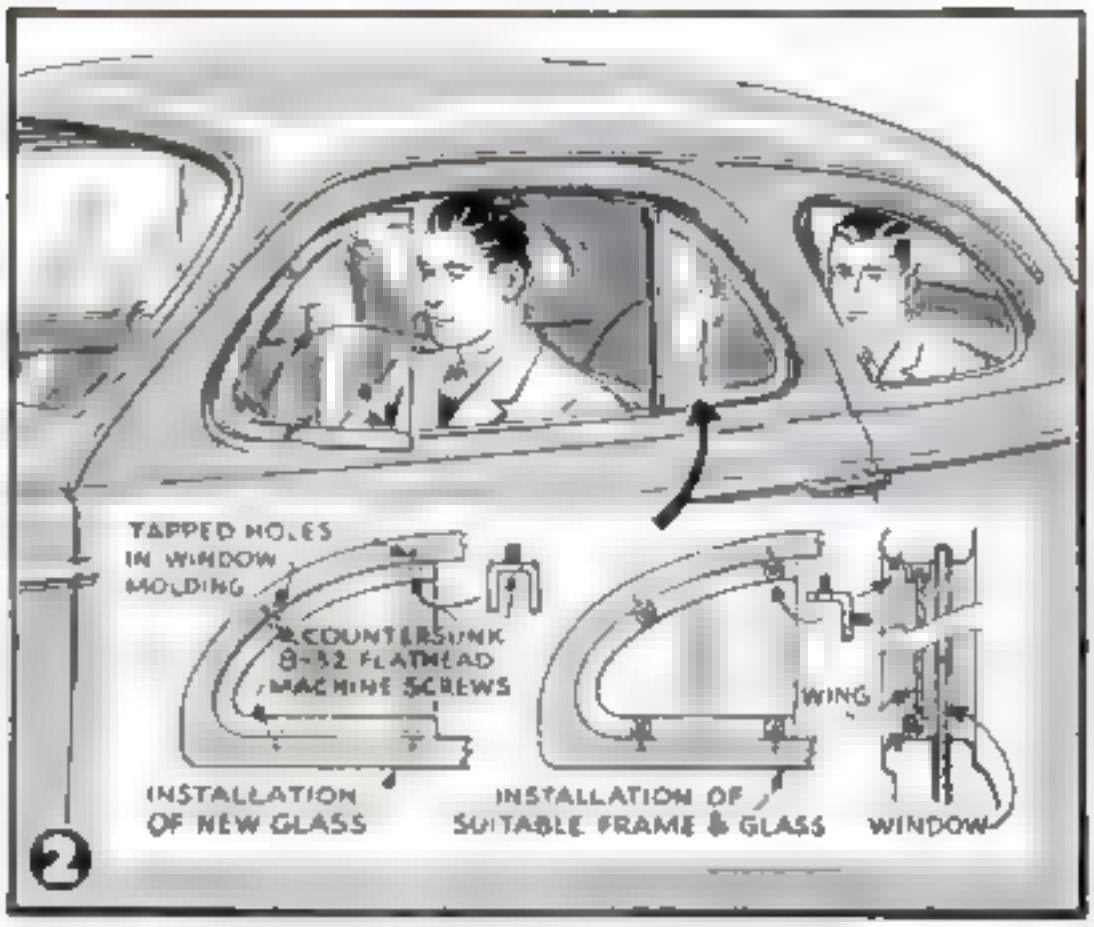


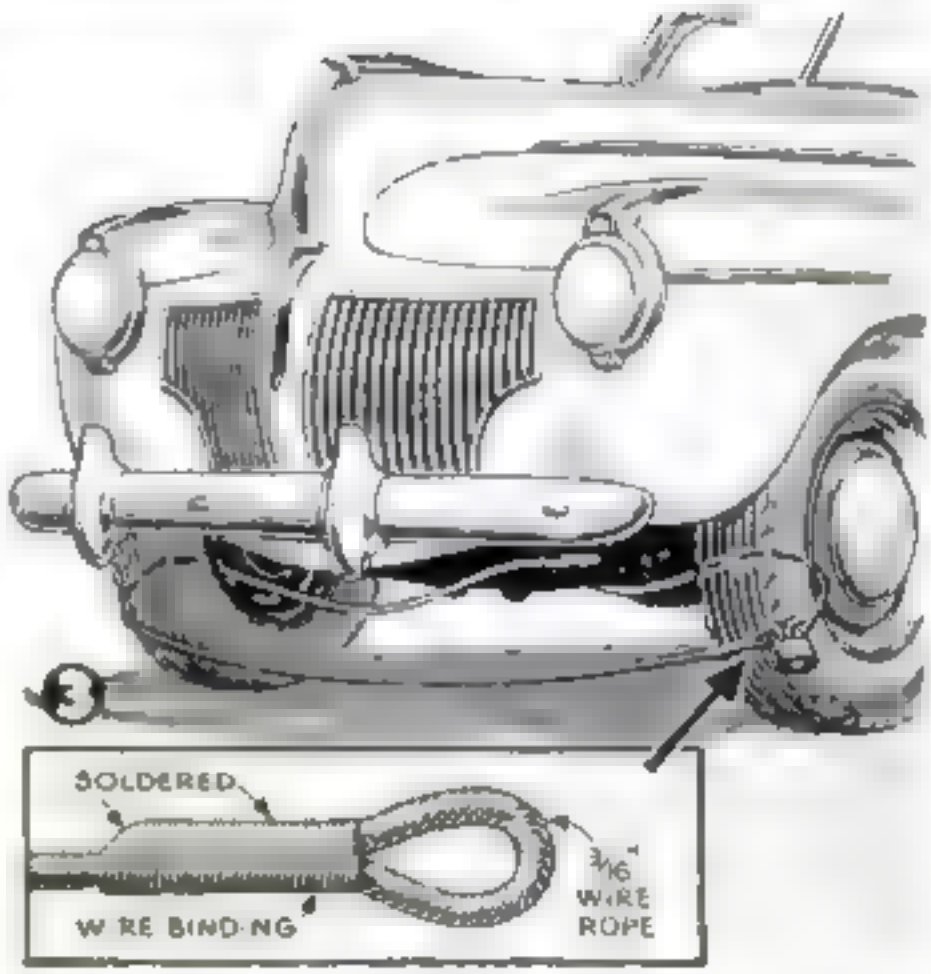
2

1 BREAKS IN GRILLS can be concealed by mounting radiator emblems over them. To do this, drill suitably spaced holes in a piece of flat stock such as heavy sheet metal and place this behind the bars of the grill, running the mounting screws through it.—J. B.

2 AUXILIARY WIND WING. Drafts coming from the wide front door of a club coupe or two-door sedan can be eliminated by the addition of a wind wing. Cut a template from a piece of stout cardboard and buy a matching wind wing at a wrecking yard. If you cannot procure a wing of the correct shape, obtain a windshield-wing frame and bend it to conform to the inside molding on the car door; then have a piece of safety glass cut to fit the frame. When fastening the frame to the door, leave about ¼" clearance so the wing will not interfere with the operation of the door glass.—A. S. L.

3 TIRE THIEVERY can be prevented by running a 3/16" wire rope through the wheels and the knee-action assembly, or else over the axle. Insert a lock through loops on the ends, which are secured by a soldered wire binding as shown.—M. S.

4 A CRACKED CYLINDER HEAD can sometimes be repaired by placing a steel plate over the crack, as shown. Two rows of holes are drilled alongside the crack, and one hole at each end to prevent further cracking. All holes are tapped, and a gasket placed between the head and the plate.—J. B.



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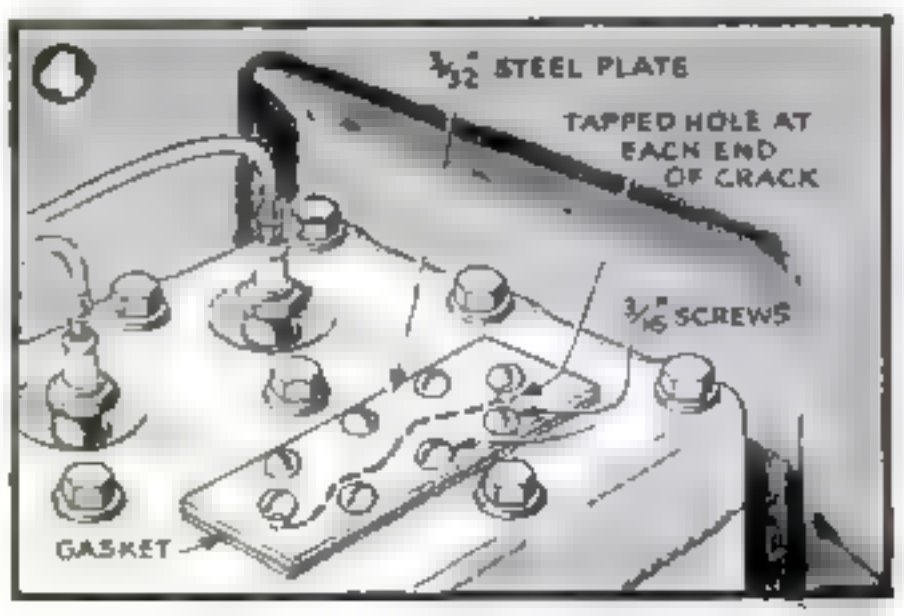
DRAWINGS BY STEWART ROUSE



4

Gus Lands a New Customer

It's Not Only in Trouble-Shooting That Little Things Count

By MARTIN BUNN

IT WAS about three o'clock of a hot spring afternoon when Joe Clark came into the Model Garage shop and found his partner, Gus Wilson, busy at his workbench scrubbing a pair of very dirty license plates with soap and water.

Joe sat down on a convenient box and said: "Phew! It's hot!" Then he asked, "What're you doing that for, Gus?"

"To get 'em clean, of course," Gus told him, grinning. "Seriously, just because there's a war on is no reason why people should let their cars look any worse than they have to. Keeping your bus clean and snappy looking is good for your morale—like getting a haircut or having your shoes shined. There's nothing that makes a car look sloppier than dirty tags, so I'm brightening up this pair."

Joe grunted. Then, after Gus had dried the plates and had taken down another jar and a brush, Joe asked, "What are you going to do now?"

"Varnish 'em," Gus said.

Joe grunted again. "Whose car is it you're taking so darned much trouble with this hot day?" he wanted to know.

"Woodward's," Gus told him. "You know the Woodwards, don't you? They live next door to Doc Marvin. Woodward's got two cars he keeps running, and he'd be a good customer for us, but somehow he's never given us anything but a couple of small jobs. Anyway, he brought his coupe in while I was at lunch, and left word he'd be back this afternoon to tell me what work he wanted done on it. Not having much to do—for a change—I thought maybe fixing up his license tags would make a hit with him, and—here he is now."

Woodward came in smiling. He is middle-aged, stout, and prosperous-looking. "Hello, Mr. Wilson," he greeted Gus cordially. "I missed you at noon, but I wanted to talk with you personally about my car, so I left word with your mechanic that I'd be back."

"I got your message," Gus nodded. "What's the matter with your coupe, Mr. Woodward?"

"That's what I'd like you to find out," Woodward said. "I've been having trouble with it for a couple of weeks—and I need the car badly. The motor doesn't run well at low speeds. Worse than that, I'm not getting the mileage I should."

"A car that wastes gas," Gus said seriously, "is right in the public-enemy class nowadays. When did you first notice this trouble?"

"Oh, a week or maybe ten days ago," Woodward told him. "The first indication of anything wrong I noticed was the motor pinging. I took the car into a garage down in the city, and they said the pinging was caused by the spark being advanced too far. So they retarded the spark. That stopped the noise, but it didn't make the motor run any smoother at low speeds, and I'm sure I'm still not getting the mileage I should."

"O.K.," Gus said.

"We'll get right at it," Joe Clark added. He walked to the door with Woodward.

A half hour later, keenly interested in the opportunity of acquiring the prosperous two-car owner as a steady customer, Joe came back into the shop. He found his partner seated on the end of his workbench, smoking placidly as he eyed the Woodward coupe.

"Find the trouble?" Joe demanded.

"Nope," Gus said, "and for a good reason. I haven't started to look for it."

"What!" Joe yelped. "Didn't you hear Woodward say he needed his car badly?"

"Sure, I heard him," Gus said. "But did you ever know anyone to come into this shop without saying that he needed his car badly and in a hurry? But all right, Joe, don't get yourself all hot and bothered. I'd

GUS SAYS:

That old battery in your bus is a mighty sensitive chemical gadget. If you leave it discharged, it sulphates and may be ruined for keeps. A battery is healthiest when it's worked good and hard. If you don't drive enough to keep it busy, have it serviced regularly.

like to land Woodward as a regular customer as much as you would. I've just been doing a little heavy thinking before starting work." Gus slid off the bench and gave his partner a playful jab in the ribs. "You ought to try that sometime, Joe—I've known it to pay dividends."

Gus climbed into the coupe and stepped on the starter. The engine took off promptly and ran smoothly at both low and high speeds. But after a few minutes there was a change. The engine still ran smoothly at high speed, but when Gus eased his foot off the accelerator pedal, the engine lost its smoothness, although it didn't actually miss.

Switching off the engine, Gus got out of the car. "It might be the fuel line," he told Joe. "I don't think it is, but I'll have a look just to be on the safe side."

He checked the fuel line carefully from tank to carburetor and found it in perfect condition. Then he checked the carburetor adjustment.

"Gas line is O.K.," he said, more to himself than to Joe. "The trouble *could* be somewhere in the ignition system. Let's see, now."

He went over the ignition as carefully as he had checked the fuel line. Distributor, spark plugs, and wiring were in good condition.

"Leaky valves?" Joe suggested.

"I don't think so. When the valves leak, the spark plugs usually get sooty, and these are clean," Gus said. "But the valves just might leak, at that. No harm in finding out."

He got the compression gauge from the instrument cabinet. After running the engine for a couple of minutes to warm it up again, he stopped it, removed the No. 1 spark plug, screwed the compression gauge into its hole, and opened the throttle all the way. Then he turned the engine over a few times with the starting motor and jotted down the compression reading on the back of an envelope. After repeating this process with each cylinder, he shook his head. "No valve leaks," he announced. "The compression is O.K. in all the cylinders, and there's only a couple of pounds variation between the highest and the lowest reading. So the valves must be all right."

Gus refilled and lighted his pipe and—as he always does when he is thoroughly puzzled—tipped his long-peaked mechanic's cap over his left eyebrow and scratched behind his right ear with a speculative forefinger. Then he suddenly started the engine and stood listening intently.

"Fuel line is all right, and so is the ignition," he thought aloud. "The carburetor is O.K. So are the valves. All the cylinders are getting gas and a good hot spark. The engine ought to run smoothly, but it doesn't run smoothly. There's a reason, but what is it?" He listened again. "Hear anything unusual, Joe?" he asked after a minute.

"Can't say I do," Joe admitted.

"I can," Gus said thoughtfully. "It sounds to me as if the engine is getting too lean a mixture. Maybe there's a leak in the intake pipe."

Gus went over to his workbench and came back with a squirt can of gasoline. He squirted gasoline on the intake-pipe joints, then listened intently again. Finally he shook his head in discouragement. "Another hope gone," he growled. "If there was a leak in the intake pipe, the engine would have sounded different when I squirted gas on the joints, because the mixture would have been richer. But I'd bet a dollar that—" He broke off and stood staring at the coupe.

"You'd bet a dollar that—what?" Joe prompted him anxiously.

Gus didn't answer. He was examining the heat-control valve on the manifold. "I've found it!" he yelled. "Look here, Joe!"

Joe went over to him.

"Know how this valve works?" Gus asked. Joe admitted that he didn't. "Well," Gus explained, "that thermostatic spring on the side of the manifold controls the position of the heat-control valve. When the engine is cold, the valve is closed, so the hot gases pass around the intake manifold and heat the mixture. This gives you smooth and efficient running when the engine is cold. As the engine warms up, the thermostatic spring gradually loses its tension, allowing the valve to open. Then the hot gases pass right out through the exhaust pipe. Get it?"

"Yes, I get it," Joe said. "But what's the matter with the valve anyway, and what's that got to do with making Woodward's bus run the way it does?"

"The thermostatic spring there," Gus explained, "controls the opening and closing of a manifold heat-control valve."

'A car that wastes gas," Gus said seriously, "is right in the public-enemy class nowadays."

Gus laughed. "The trouble is," he said, pointing to the valve, "carbon has formed on the valve shaft and makes it stick in its closed position. With the valve staying closed after the engine warms up, the hot gases, instead of passing out through the exhaust pipe as they should, keep on passing around the intake manifold.

"This heat," Gus continued after a pause, "causes too great an expansion of the gas inside the intake manifold, and the result is that too little vaporized gas enters the combustion chamber. That causes poor engine performance, especially at low speeds.

"Freeing the heat-control valve so it'll work properly will improve the performance of the engine and also increase the mileage. That's what Mr. Woodward wants, so it ought to please him now that we've found the cause of his trouble. I'll have it fixed in a jiffy."

"Huh!" Joe grunted disgustedly. "That's not much of a job, is it? I was in hopes this would turn out to be something serious —the kind of a job that would let us show Woodward the high-class repair work we can do. Customers never give you any credit for finding out what's the matter with a car—but most of 'em are impressed when you do a job that costs them plenty but makes their bus run like new. They like to think it was a big job—something that nobody else could have done—and also that they're getting a lot of money's worth."

"Check!" Gus said.

Two days later Joe Clark came high-stepping into the shop from the office. A wide grin decorated his usually serious countenance.

"What are you looking so darned pleased about now?" Gus demanded of his partner. "Has somebody dropped one of those block-buster bombs on Hitler, or has gas rationing been called off by Washington all of a sudden?"

"Unfortunately, no," Joe said. "But Mr. Woodward just called up and said that from now on he is going to give us all his business."

"Good!" Gus exclaimed. "Well, there's one customer who appreciates a good trouble-shooting job."

Joe shook his head. "That's where you're all wrong," he said. "Mr. Woodward didn't say a word about your getting his coupe running right again. What converted him to the Model Garage was the way you cleaned up his license plates."

Gus looked disappointed. Then he laughed. "Oh, well," he said, "so long as you catch the fish, what difference does it make what kind of bait you use?"

For cheerful living in crowded quarters . . an artificial fireplace that provides more storage room than the average chest of drawers and doubles on short notice as table, desk, or vanity

Simply Built Utility Mantel

Packs a Lot of Real Living Convenience into Little Space

HAVE you ever wanted a fireplace in your house or in your one- or two-room apartment? Here is an artificial fireplace that will not only fulfill that wish, but also provide extra conveniences.

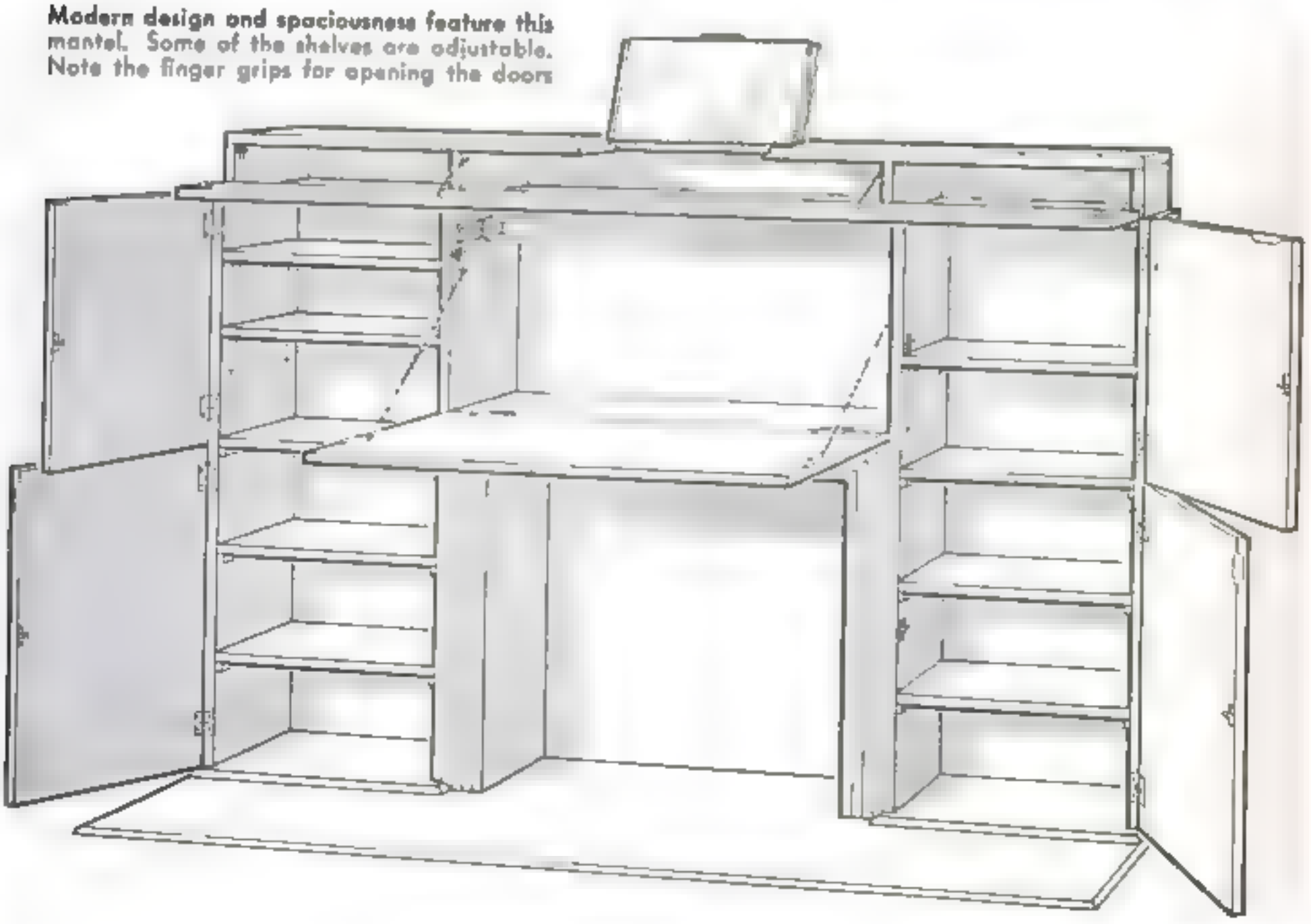
This mantel, built entirely of pine and plywood, has storage space for clothing and other articles, a mirror for shaving, and a drop front that can serve as a vanity table, desk, or breakfast bar. Some of the compartments are of just the size to take shirts folded at the laundry, an unusual feature.

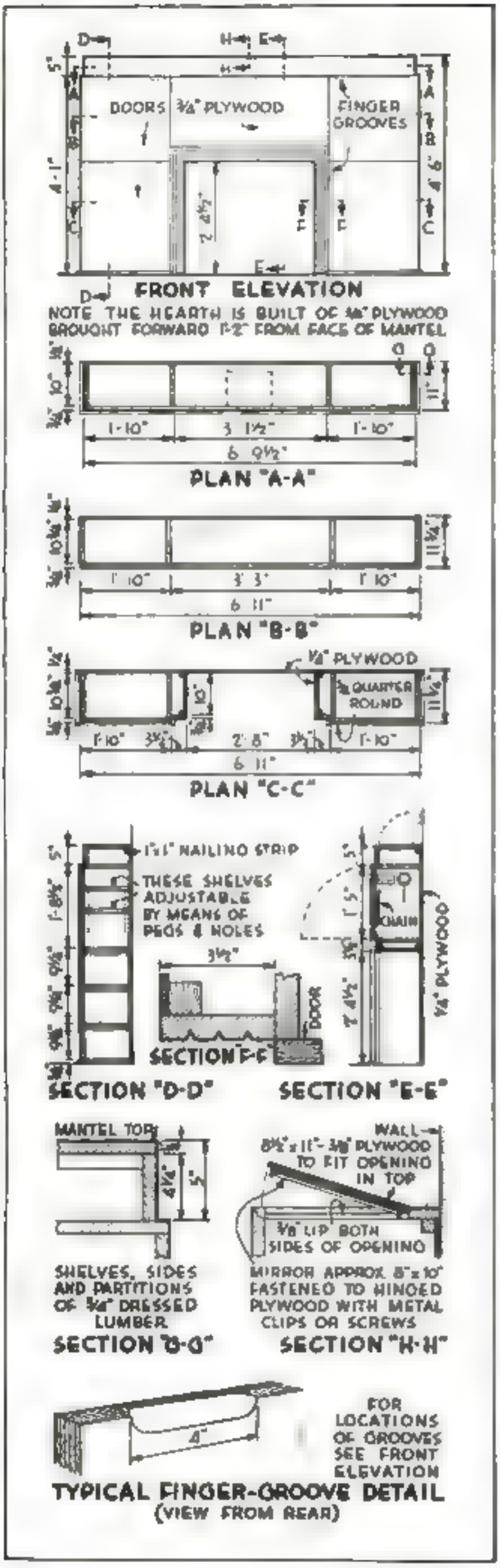
The original design was the work of Miss Corinne Pascoe, of Brooklyn, N. Y., whose utility mantel is shown in photographs on the following pages. From her basic idea, the staff of POPULAR SCIENCE developed the modern mantel described here. Either mantel can be built with simple tools, but as in all such projects, power tools will speed the job.

Because of the large over-all dimensions, it is best to saw the pieces and make a trial assembly in the workshop, after which final assembling can be done in the room for which the mantel is intended. Cut the two endpieces, the two partitions, and the two bottoms to size. If the floor of the room is not level, the lower edges of the ends and partitions may be cut slightly out of true to allow for the variation. Next, attach the shelf cleats and bore holes for the shelf pegs. Fasten the ends and partitions to the bottoms with screws through the latter, and tack a board temporarily across the top of each unit to hold it rigid until the back and top shelf are attached later.

Cut the three moldings (section F-F) and miter the joints. Attach the 1" by 1" strips to the two side moldings and the other strip to the horizontal molding that goes across the top of the fireplace opening. Fit the ¼" plywood panels to form the sides and top of the inside of the fireplace; then attach the three rear strips to the rear

Modern design and spaciousness feature this mantel. Some of the shelves are adjustable. Note the finger grips for opening the doors





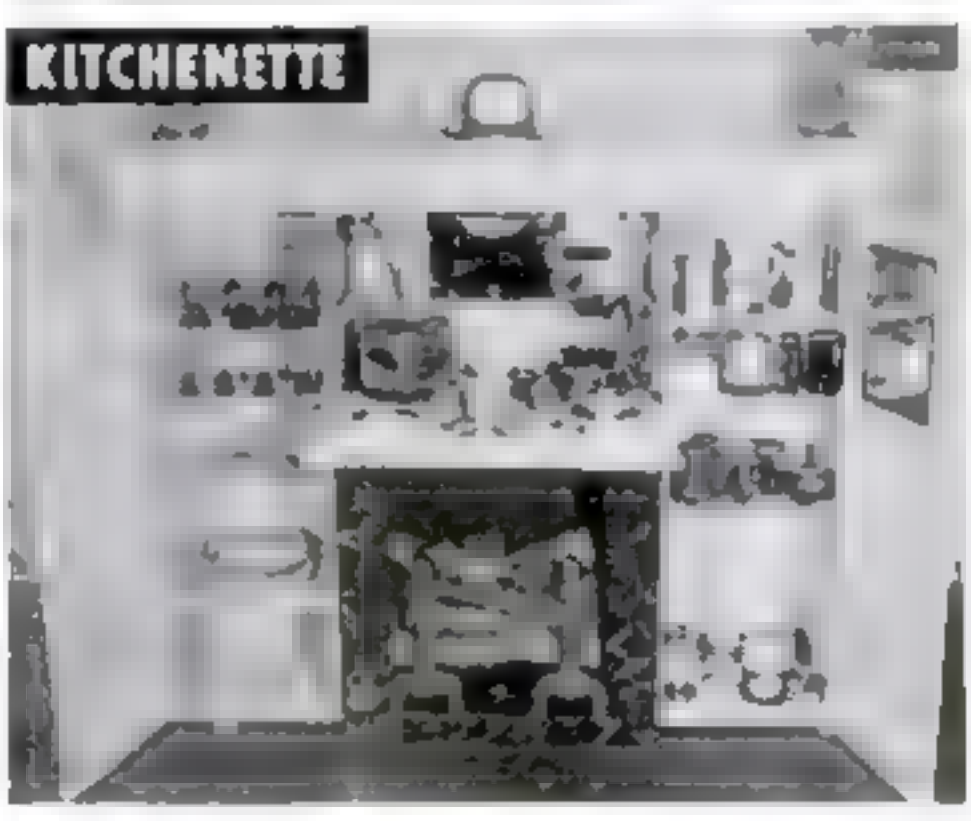
edges of these plywood pieces. This assembly is fastened to the ¼" plywood back of the whole piece.

After the shelves, back, ¾" plywood hearth, and top unit with ends and partitions are cut to dimensions, the mantel is ready to set up. Remove the temporary boards and attach the full-length top shelf. Next, fasten the top unit with ends and partitions to the top shelf. Then put the center shelf in position. After this, attach the fireplace assembly and back to the uprights, shelves, top, and bottoms of the mantel unit.

The fireplace moldings are fastened to the two partitions with screws through the partitions, and to the front edge of the center shelf with three fine finishing nails. Set the nails and putty the holes with white lead and whiting. Flathead screws, with the heads slightly countersunk, give a neat appearance and can be withdrawn if the mantel is to be taken apart for moving.

The doors and drop fronts should be fitted

How One Ingenious Woman



after the mantel has been set up true and plumb on the hearth. Use four hinges on the long drop front, providing clearance for them by cutting a relief bevel on the upper doors and drop shelf. If the wall has a baseboard and molding, it may be well to use a wider board for the mantel top and filler strips along the sides to close the gap between them and the wall. A flat or semigloss wall paint may be used for finishing.

LIST OF MATERIALS

No. Pc.	Description	T	W	L.
2	Ends	¾	10½	48½
2	Partitions	¾	10½	48½
10	Shelves	¾	10½	20½
1	Shelf	¾	10½	83
1	Top	¾	10½	81½
2	" ends	¾	4½	10
2	" partitions	¾	4½	10
1	Center shelf	¾	10	39
2	Bottoms	¾	11½	22
1	Back (plywood)	¼	54	83
2	Moldings	¾	3½	32
1	Molding	¾	3½	39
2	Fireplace sides (plywood)	¼	10	28½
1	" top "	¼	10	32½

No. Pc.	Description	T	W.	L.
1	Top drop front	¾	5	81½
1	Center drop shelf (plywood)	¼	17	39
2	Upper doors "	¾	20⅞	22
2	Lower " "	¾	22	27⅜
1	Mirror back "	⅜	8½	11
1	Hearth "	¾	25½	66
2	Moldings (quarter-round)	¾	¾	12¼
2	" " "	¾	¾	29½
2	" " "	¼	¾	1½
1	Nailing strip	1	1	81½
4	" strips	1	1	28½
2	" "	1	1	39
12	Shelf cleats	¾	¾	10½

7 pair hinges, 6 friction catches, and 4 chains.

Note: All dimensions are given in inches and are finished sizes.

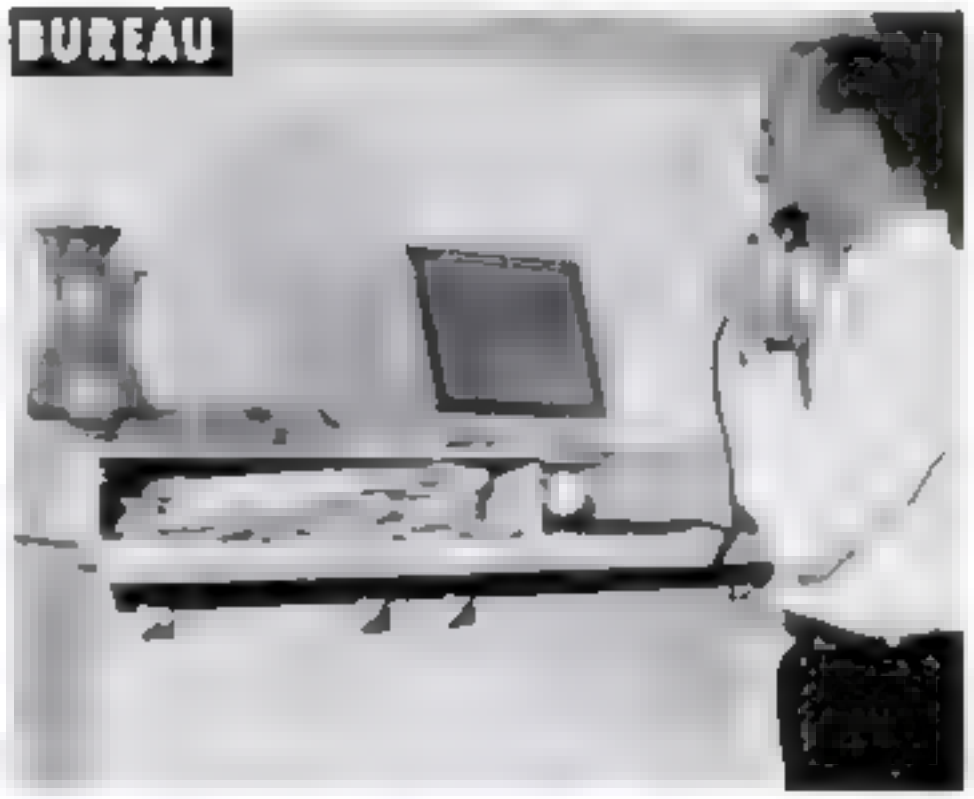
Built a Mantel to Fill Many Needs in a Compact Home

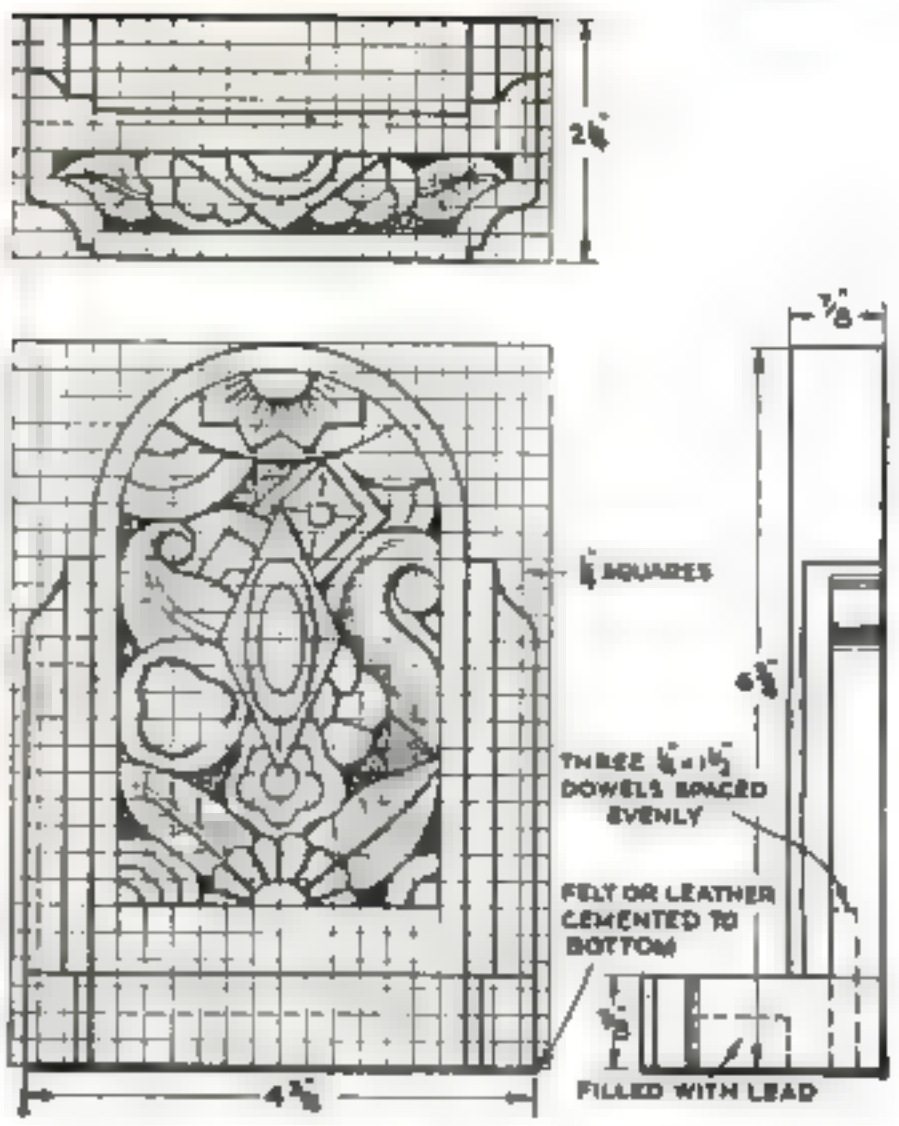
THIS IS THE WAY Miss Corrinne Pascoe designed the original utility mantel for her home in Brooklyn, N. Y. The photographs show it fitted out as a pair of utility closets, a kitchenette, a bureau, and a vanity.

Miss Pascoe used the most elementary of tools—a small gimlet for starting nail and screw holes, a hammer, a saw, a screw driver, a pencil, and a tape measure. She drew her plans carefully, decided on the kind and thickness of wood for each part, took exact measurements, and had all the stock cut to size at a lumber yard. This method of construction will eliminate almost all sawing and make it possible for an apartment dweller to construct the piece with a minimum of noise that might disturb neighbors.

If this plan is followed, the dimensions should be set down on paper and checked against the drawings to be sure that each piece will fit when it is delivered. Once these dimensions are decided upon, no change should be made unless the builder is prepared to recheck the entire list, for different woods may vary slightly, especially in thickness, causing bad alignment.

Decorations used on Miss Pascoe's mantel are marble facings for the fireplace and half-round molding and ornamental wood trimmings for the doors. The electric fixtures and logs connect to a near-by outlet.





Their unusual carved motif makes these book ends an intriguing project for the craftsman

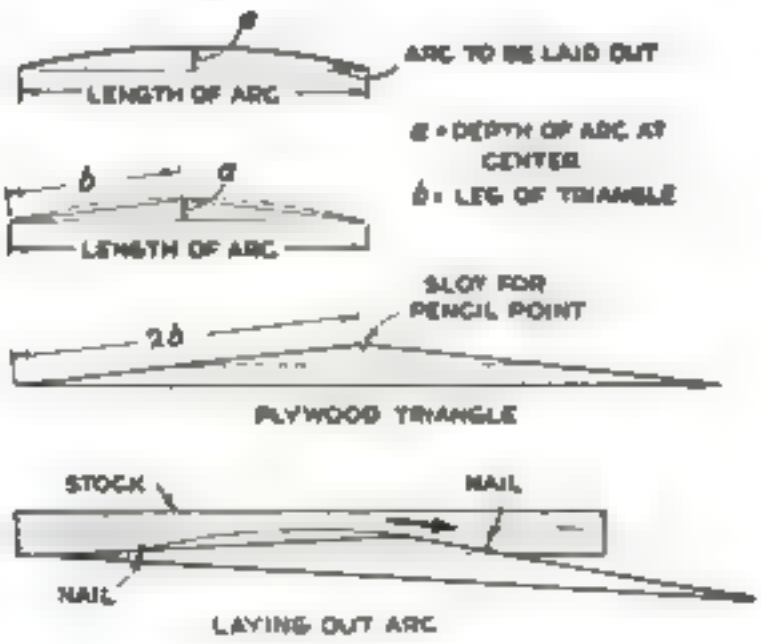
Hand-Carved Book Ends Have Interesting Relief Design

THIS attractive pair of book ends, which was carved by a native Hawaiian, can be readily duplicated by the home craftsman. Any available wood having an interesting grain can be employed. Ordinary wood-carving tools, either manually or machine operated, may be used in carving the design, although an electric grinder or a drill press equipped with wood-cutting burrs will be found useful in routing out the background.

From the accompanying drawing of the design, draw a full-size pattern on ¼" squares. The upright is 5⅞" high by 4⅝" wide and is attached to a ⅞" thick base by means of three evenly spaced dowels and casein glue. Before attaching the base, recess it on the underside to receive a block of lead or iron of suitable size to afford sufficient weight. Rough leather or felt is cemented along the bottom of the base to prevent slipping on polished surfaces and to protect furniture from being scratched.

The book ends should be nicely finished with shellac and wax, or with stain and shellac, depending upon the nature of the wood used.—HI SIBLEY.

LAYING OUT A LARGE ARC [WOODWORKING]



TO DRAW an arc with a very small curvature on such work as the back rail of a chair, a curved drawer front, part of a garden arbor, and the like, proceed as follows:

Measure the length between the ends of the desired arc and also its center depth. Connect these points, making a triangle. Construct a similar triangle, with legs twice as long, from thin board, and at the apex cut a notch for a pencil. Drive two nails into the work at the end points of the arc to be laid out and place the wooden triangle in contact with both nails. Holding a pencil in the slot, move the triangle from side to side. A perfect arc of the correct size will be drawn.

POPULAR SCIENCE MONTHLY SHOP DATA

TANK BLOTTER

Also Holds Clips, Stamps, and Other Desk Accessories

By MYRON FLEISHMAN

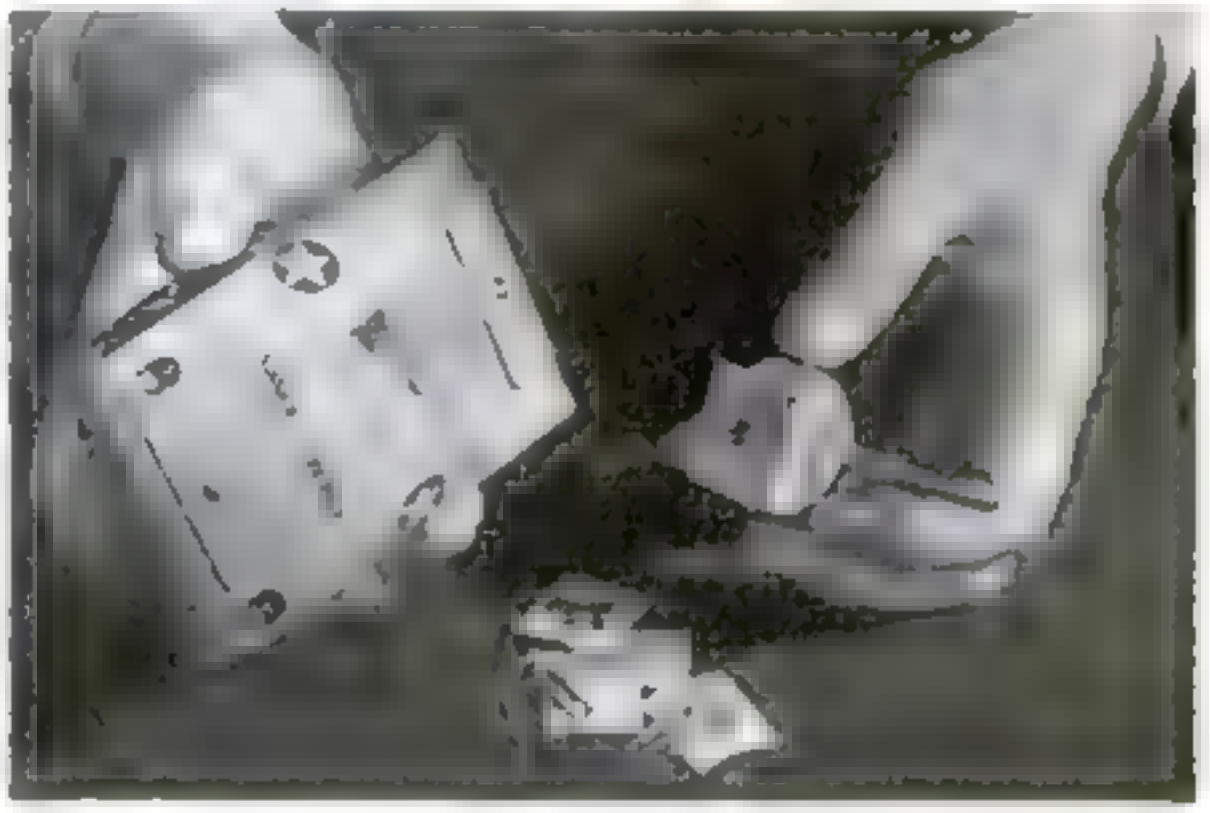
THE LITTLE tank shown here doesn't pack a real gun, but it makes a novel desk blotter and container for stamps, clips, pen points, and the like.

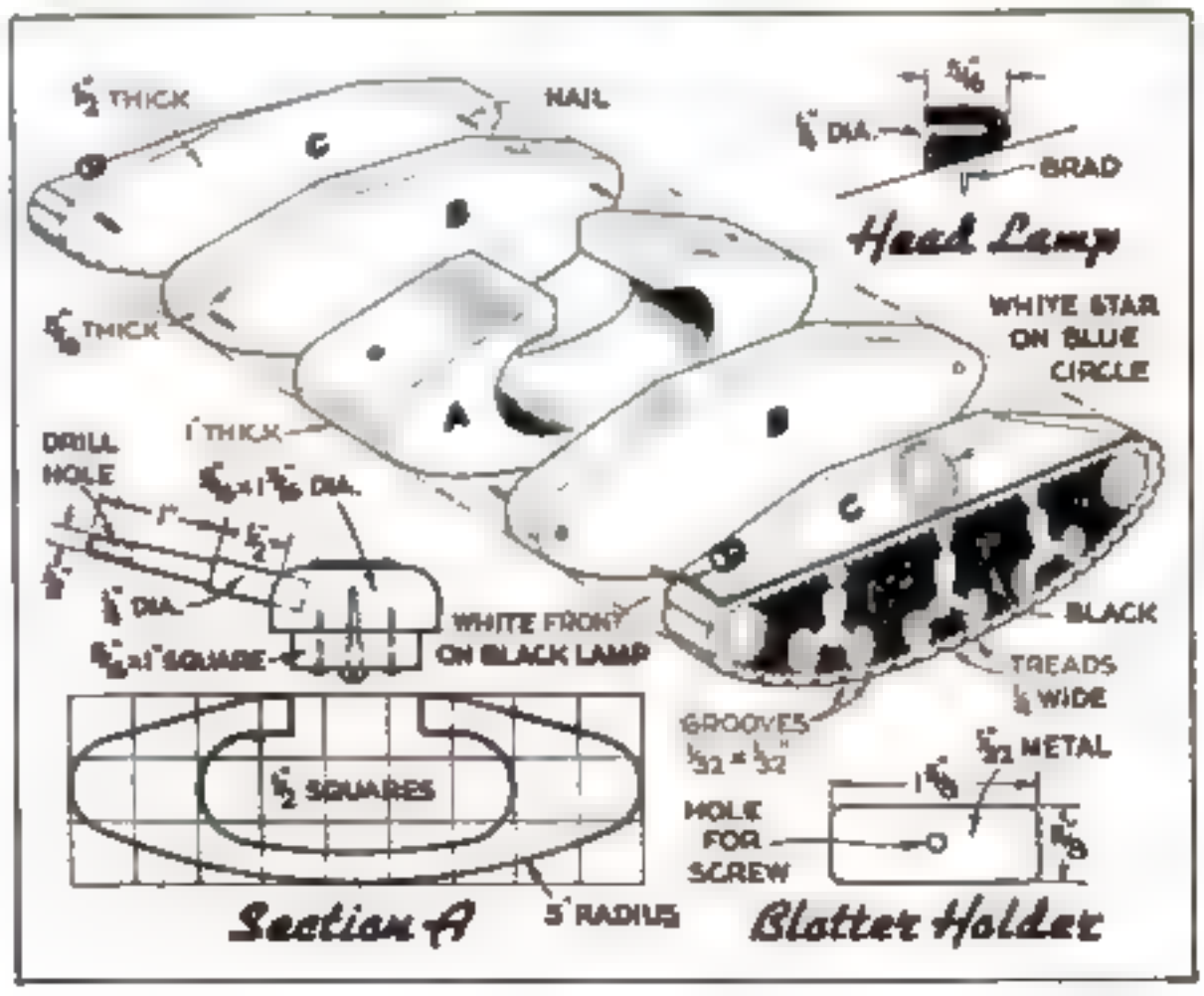
Five sections of wood comprise the body of this realistic tank. The center section *A*, as shown in the drawing, contains the compartment recess and is cut from 1" stock. Sections *B* are of 5/16" stock and are glued or nailed to the sides of *A*. Make sections *B* slightly larger than *A*. After gluing or nailing, sand, plane, and file them down flush with *A*. The outside sections *C* are of ½" stock and are planed down to match sections *B* but are not glued on at once. After planing sections *C* to size, use a hacksaw blade to cut the grooves or "treads" of the tractor; then glue together.

The square block which is screwed and nailed to the underside of the turret should be made to fit the compartment beforehand.

Turn the turret and gun on the lathe or whittle and sand to shape, fitting the gun in a slightly raised position to the turret. Headlights are fashioned from a piece of dowel ¼" in diameter and 5/16" in length. The two blotter holders are of 5/8" by 1 5/8" sheet metal, with beveled corners. Cut the blotter 1 5/8" in width and clamp it fast by the two ends.

Ready, aim . . . blot! This novel tank will add a military touch to a desk. The compartment under the gun turret holds stamps and clips





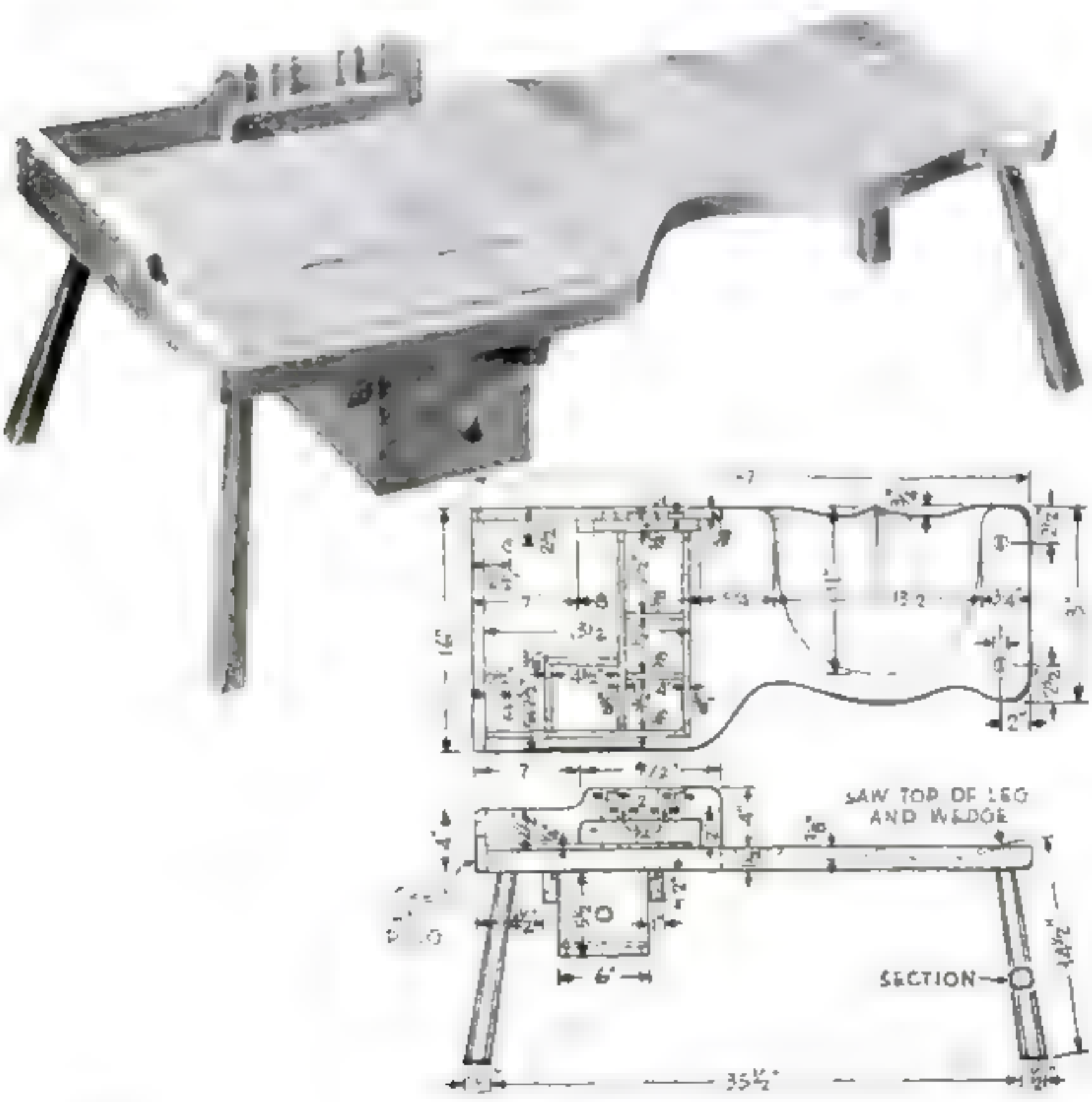
Cobbler's Bench Has

By FRANKLIN H. GOTTSHALL

THIS cobbler's bench, which has the authentic lines of an original, makes a quaint and charming coffee table for use in the living room. The traylike compartments will hold cigarettes, candies, nuts, cookies, and the like. Niches in the back of the bench form holders for pipes, drinking straws, paper napkins, spoons, and other small articles. The drawer may be pulled out from either side and is convenient for keeping chessmen, playing cards, dominoes, and similar game accessories.

To make the bench, first glue up or procure a plank for the top. Although the one shown was made of Georgia pine, any yellow or white pine will do if it is kiln dried to avoid warping, or maple may be used. Before rounding the corners for the seat, mark the place where the holes for the legs are to be bored.

A drawing shows the proper method to use in boring these holes. For each corner, draw lines parallel to the edges and bisect the angle thus formed with a third line. Using a protractor or a sliding T-bevel adjusted to the proper angle, line up the bit to bore the hole. In getting this angle, be sure that the bit is kept in the same plane as the bi-



Old-Time Charm

secting line while boring. Once the screw of the bit has penetrated the surface, finish boring from the other side to prevent splintering.

Scoop out the saddle seat with large wood-carving gouges. Clean up the saddle with a curved scraper blade, and sandpaper to a smooth finish. Finally, bandsaw the top to shape, notching the edge where the side containing compartments is to be fitted.

The legs should be made of extra strong wood such as maple, and they should be tapered and trimmed to an octagonal shape after the ends which go into the seat have been turned. Kerfs are cut in these ends on the band saw for wedges which help anchor them securely in the seat. Glue is used in addition to the wedges.

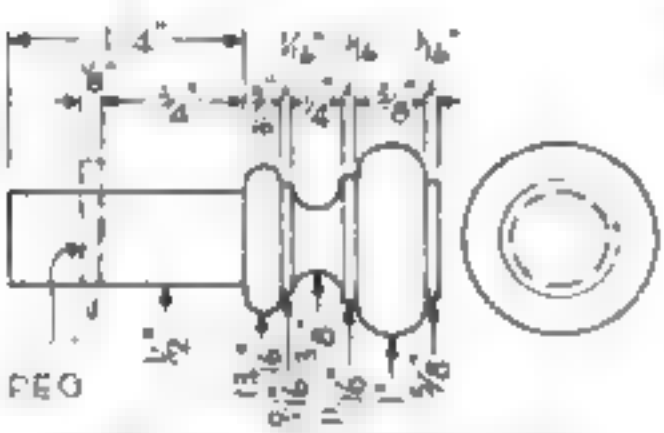
The three side compartments are gains and do not go clear across the stock. After boring holes for the screw heads, glue and screw the piece to the seat. Next, glue and screw on the side block and end, the former from the back as shown in the drawing.

When the drawer has been made and fitted, brad and glue the strips to the top to form the trays, and turn the drawer pulls. Finish the bench very carefully with stain and varnish.

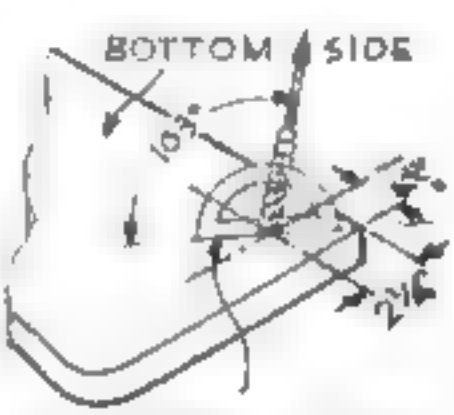
List of Materials

No	Description	T.	W.	L.
1	Top	1½"	16"	36¼"
1	Side	¾"	5½"	16½"
1	Side block	¾"	2"	8"
1	End	¾"	4"	15¼"
2	Drawer supports	1"	2"	15½"
2	Drawer strips	½"	½"	15"
2	Drawer ends	¾"	5½"	6"
2	Drawer sides	½"	5½"	14½"
1	Drawer bottom	¼"	5½"	14"
1	Strip	¼"	⅜"	13⅝"
1	Strip	¼"	⅜"	13¼"
1	Strip	¼"	⅜"	13½"
2	Strips	¼"	⅜"	4"
2	Strips	¼"	⅜"	4⅜"
4	Legs	1½"	1½"	14½"
2	Drawer pulls	1"	1"	2¼"

Great care must be taken to bore the leg holes at the proper angle, as shown below. The joints of the drawer are cut with a dado head on a power saw. If made with hand tools, they should be dovetailed

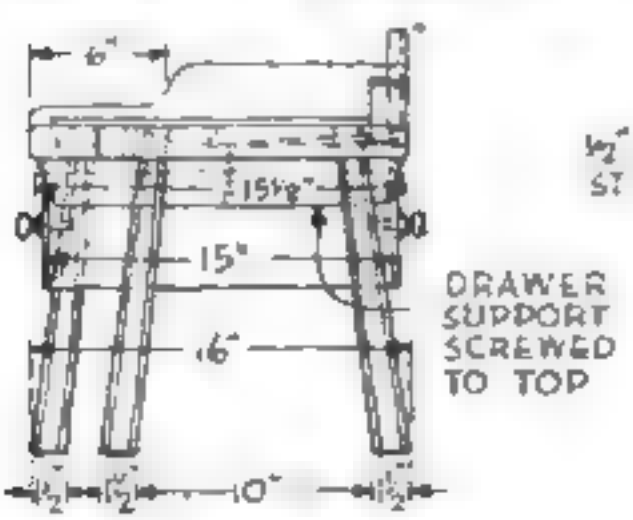


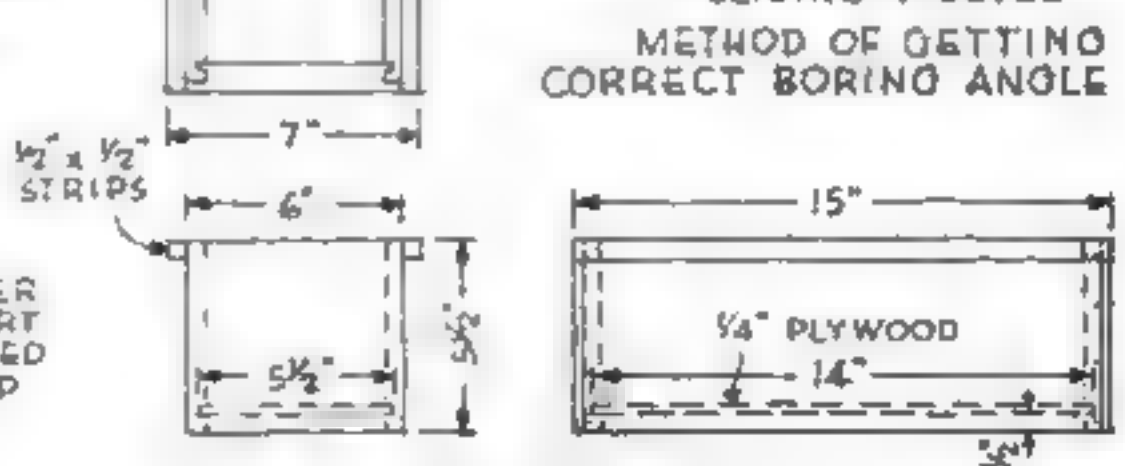
DETAIL OF DRAWER PULL



USE PROTRACTOR OR SLIDING T-BEVEL

METHOD OF GETTING CORRECT BORING ANGLE





DRAWER CONSTRUCTION DETAILS

COTTAGE FOOTSTOOL

Has Compartment for Slippers

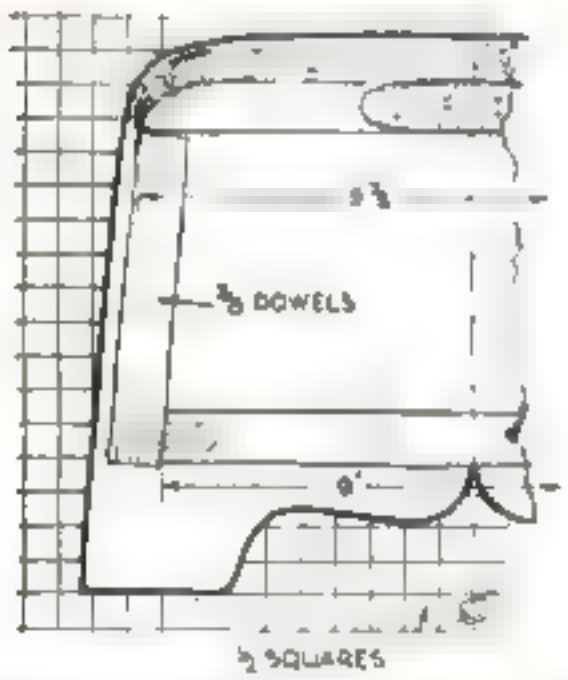
THE straightforward design of this useful footstool adapts it to any room with American furniture, and particularly for use with maple furniture. There is a provincial atmosphere about it that is enhanced by its upholstered top and slipper compartment. The parts and construction are comparatively simple.

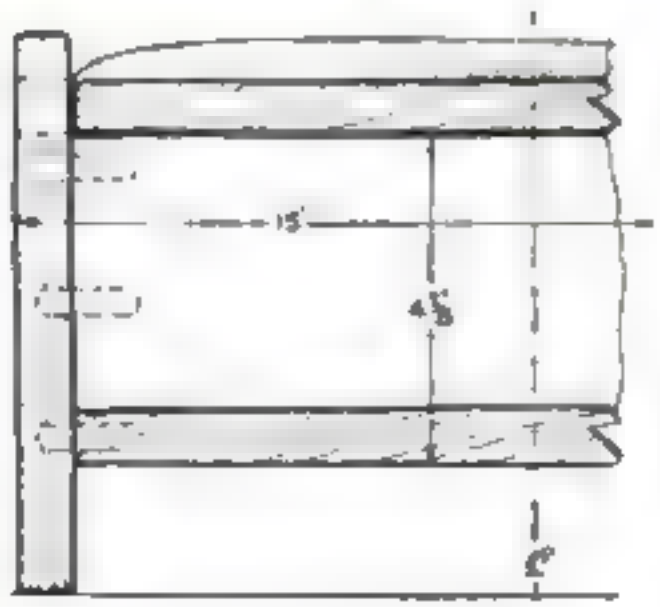
Boards required to build this stool are all the same thickness, the cutting is along plain lines, and the end joints are merely doweled and glued. Further simplification can be made by the use of nails, screws, or exposed dowels.

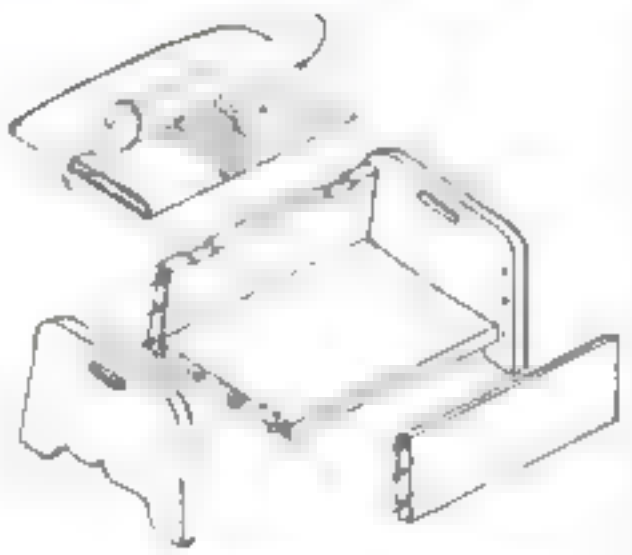
Cut the endpieces to shape and form the handle slots by boring three ⅝" holes and two ½" holes, then cutting away the excess wood with a keyhole saw. Cut the floor next, being careful to bevel the two long edges so the sides will have the proper slope. The sides may be made square, without beveled edges. The lid is cut ⅛" smaller all around so that it will lift freely, and the two long edges are rounded off generously.

After assembling, round all edges of the stool with sandpaper to give a slightly worn appearance. Finish to taste. The original model was made of soft pine, stained light brown, given a thin coat of shellac, well rubbed and waxed.

The upholstery consists simply of a layer of cotton, hair, or excelsior, with a scrap of material—in this case leather from an old brief case—drawn neatly over the four edges and tacked to the underside of the top. Tapestry or upholstering material that is harmonious with other pieces of furniture in the room may also be used. Screw on the hinges after the upholstering and finishing are completed.







Designed by JOSEPH ARONSON

LIST OF MATERIALS

No.	Description	T.	W.	L.
2	Ends	¾	8½	11½
2	Sides	¾	4	13½
1	Floor	¾	9	13½
1	Lid	¾	9⅛	13⅛

Pair small cabinet butts

Note: All dimensions are given in inches

RUSTIC NAME POST

ATTRACTIVE name and house-number boards can be made of scrap lumber and a tree branch or sapling log. A crossbar and brace made from a branch support the name board, which is suspended with short lengths of rope run through heavy screw eyes. Remove the bark from the end of the post that goes into the ground. Paint this with creosote to prevent decay.

Use a smooth board with jagged ends and leave it unpainted. Carve the lettering with a V-shaped chisel, paint it dark brown, and apply two coats of outdoor spar varnish. A color effect is obtained by burning the board slightly, brushing with a wire brush, and painting the letters Chinese red.

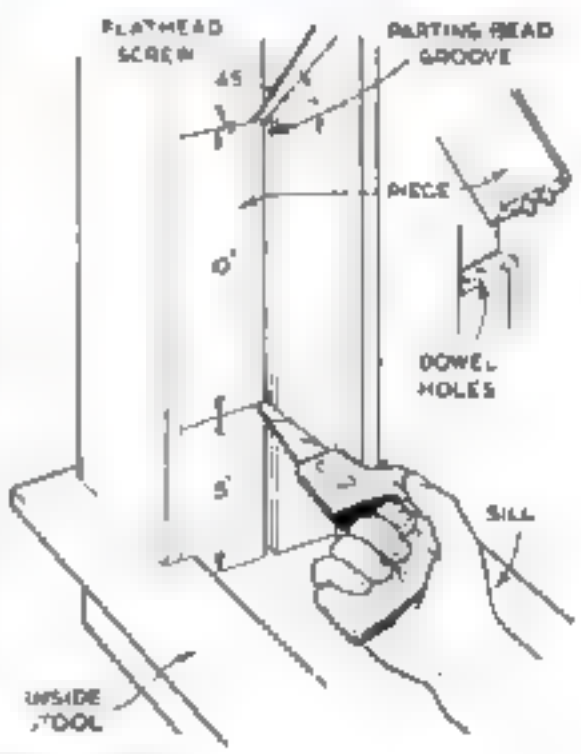
abcdefghijklmnopqrstuvwxyz
ABCDEFGHIJKLMN
OPQRSTUVWXYZ

CUTTING WINDOW POCKETS

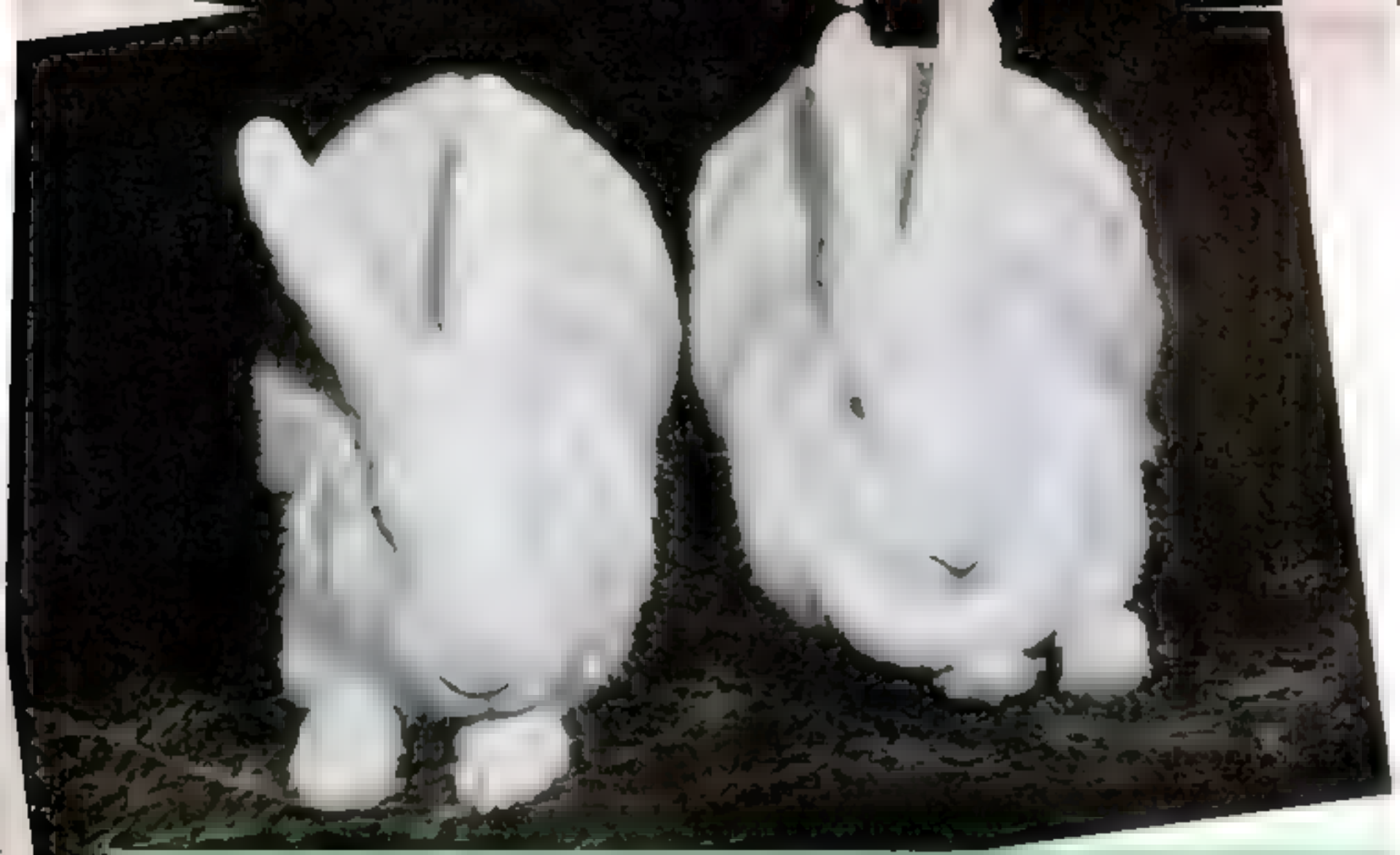
[SHIPSHAPE HOME]

Pocket openings for removing sash weights are omitted in many frames, but they can be cut out without much trouble when damaged sash cords must be replaced. Remove the stop, lower sash, and parting bead. Square pencil lines across the pulley stiles as guides, and bore a hole in the parting bead groove on each line. With a compass or keyhole saw inclined at 45 deg., cut along the upper line; then saw the lower end square across. Rip the stile down in the parting-bead groove. Pry out the piece. If a nail from the casing enters it, cut the nail off behind the casing, or pull it out with pliers.

Bore two shallow holes in the pulley stile to receive dowels set into the lower end of the cut-out. Incline the dowels slightly to fit. To replace the piece, slip the dowels into the holes and put a flathead screw into the upper miter cut. Adjust the fit by the length of the dowels. Replace the parting bead, sash, and stop.



POPULAR SCIENCE MONTHLY SHOP DATA



How to raise Rabbits

FOR QUICK MEAT PRODUCTION

By ANDREW R. BOONE

YOUR corner meat market is no longer as well stocked as it used to be, and the butcher now requires ration stamps as well as cash. Why not stretch your ration with home-raised meat? Experts agree that rabbit meat is a high-protein muscle and body builder, and that rabbits produce one of the best all-around meats in less time than any other domestic animal or fowl.

Four to six does and a buck, which can be housed in a small space, ought to provide the average family with one or more hearty meals every week.

Of the many varieties of white rabbits available, the New Zealand, Flemish Giant, American, Beveren, French Silver, and Chinchilla are the best producers. Although it is a good idea to get one of these white breeds because white pelts are generally more desirable than darker shades, the choice is entirely one of personal preference. Angora rabbits provide both good meat and useful wool, which can be clipped from the live animals at intervals.

Fryers weighing 3¾ to 4½ lbs. will be ready for the table in two months, and they'll dress at better than two pounds. Heavier rabbits will yield much more meat and are preferable for stews and fricassees.

Rabbits make little trouble and thrive on quiet and good treatment. They will happily munch garden waste such as vines and leaves, lawn clippings, and palatable weeds, as well as table scraps.

You may, advises George S. Templeton, Director of the United States Rabbit Experiment Station at Fontana, Calif., start your foundation stock either with young rabbits just weaned or with mature animals. To speed production, you should buy an older doe—one that has already been bred with a buck not related to her. Additional information about breeding and rabbit rearing can be had from the Fontana station, or from the Director, Fish and Wildlife Service, Merchandise Mart, Chicago, Ill.

There is no hocus-pocus about hutch building, either. Just be sure the hutch can be kept clean easily, thus simplifying the task of care and feeding. Wildlife Leaflet No. 218, "Domestic Rabbits in the Food for Freedom Program," published by the Fish and Wildlife Service, recommends an inexpensive hutch having two compartments as suitable for home rabbit raising. Copies of this leaflet, from which much of the other

These easily raised animals provide fryers in record time. New Zealand whites, such as are shown on the facing page, are a good breed. The buck, or male, is at left

Equipment for the back-yard rabbitry need not be costly. Materials for a self-cleaning hutch (above) are listed on the next page. Right, a nesting box made from a nail keg

material in this article was obtained, can be obtained from the Chicago office.

The hutch mentioned is of the self-cleaning type with a floor made of 1" by 1" slats spaced ½" apart. The hutch is 4' long, 2½' wide, and 2' high. The photo above shows the hutch, and the lumber required is listed in the bill of materials on the next page.

Other items you need include mangers large enough to hold a 24-hour supply of hay and so constructed that you can fill them from the front without opening the hutch doors, feed troughs of the drawer type to be placed under the mangers, guards over the mangers at 3" intervals to prevent young rabbits from contaminating the feed, water containers—preferably crocks—about 8" wide and 4" deep, and nest boxes. The last can be made from nail kegs or boxes as shown in the drawings above.

Rabbit breeding can be started at any time, regardless of season, for each doe should be bred to produce four litters a year. Does and bucks of small breeds may be mated when five to six months old, medium-weight animals at six to seven months, and giants at nine to twelve months. Mating should be undertaken when the doe is coming into maturity. At its completion, the doe should be confined to her own hutch.

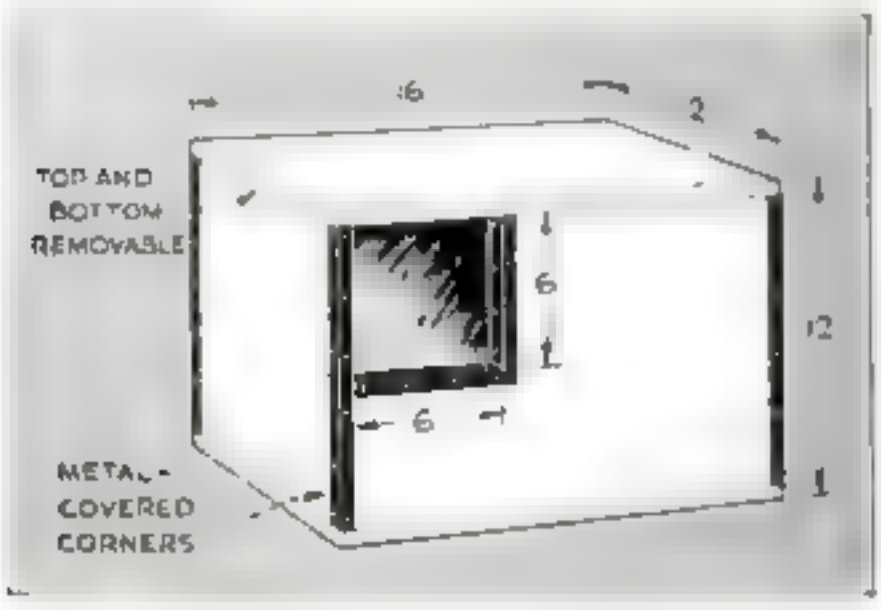
A doe will carry her young 31 to 32 days. During the third week after mating, place a nest box in her hutch, bedding it well with clean straw. She will usually arrange her own nesting material, lining it with hair pulled from her body.

The next day following kindling, place your hand quietly in the nest and remove any dead, deformed, or undersized young, leaving six to eight, depending upon the suckling ability of the doe. You can even transfer newly born rabbits from one doe to another to even up litters, but this must be done within the first two or three days after birth of the young.

Fryer rabbits are ready for consumption when they are weaned at 60 days of age, but they can be kept together in one hutch for two months longer. It's a good idea to rebreed the doe immediately. Any does and bucks you plan to keep for breeding purposes should be separated from the litter after weaning time.

Never lift a mature rabbit by the ears or legs. The proper way to carry a grown rabbit is to grasp a fold of skin over the shoulders with one hand, support the rump with the other hand, and hold the back of

Mature rabbits should be carried by grasping the skin above the shoulders and supporting the rump



MATERIALS FOR CONSTRUCTING TWO-COMPARTMENT HUTCH

No. Pc.	Description	T.	W.	L.
4	Front corner posts	1	2	56
4	Rear corner posts	1	2	50
2	Top front and rear	1	2	96
2	Bottom front and rear	1	2	96
2	Bottom ends	1	2	30
2	Top ends	1	2	32
4	Front and rear braces	1	2	40
4	End braces	1	2	24
2	Door jambs	1	2	22
4	Horizontals of doors	1	2	24
4	Verticals for doors	1	2	22
2	Door latch pieces	1	1	4
2	Supports under slat floor	1	1	96
54	Floor	1	1	30
2	Sides of base under feed trough	1	2	28
1	Top of base under feed trough	1	8	28
1	Bottom of feed trough	1	8	29
1	Front and of feed trough	1	2	8
1	Manger front (V-shaped opening 9" by 14")	1	12	22
1	Manger back	1	12	16
1	Manger bottom	1	2	28
4	Manger strips for attaching wire netting	1	1	18
2	Manger top	¼	8	28
13	Roof	½	8	36
12	Roof battens	½	2	36
2	Hutch boards for record cards	½	4	8

1 ¼" Wire mesh, 18 gauge, 28" by 30" for hay manger
1 1" Wire mesh, 18 gauge, 24" by 13' for front, doors, and ends
1 1" Wire mesh 18 gauge 18" by 8' for back
2 Tin 2⅛" by 30", for feed-trough sides
4 20d box nails for hinges
18 20d nails, spaced 3" apart, for guards of feed trough
6d nails and wire-mesh staples

Note: All lumber dimensions are given in inches.

the rabbit well cushioned against your body.

Rabbits require a minimum of attention except during severe hot and cold weather. Young rabbits can stand low temperatures once they are dry, providing they have a warm nest and a good covering of fur. To keep young litters and does ready to kindle from suffering in hot weather, place feed sacks on the hutch floor and wet them three or four times a day. Don't make the mistake of wetting the animals. This may bring on colds and pneumonia. If the very young become restless in hot weather, place them in a 6" by 6" by 15" wire basket hung inside the hutch, but return them to the nest box when the thermometer falls to normal.

There is no need to worry over the feeding problem. Rabbits will eat whole grain, provided it is free from mold or smuts. If the grain is mixed with fine meal, dampen it slightly to keep the meal from settling to the bottom of the feed trough. All table scraps may be fed excepting sour and greasy items. So may vegetables, lawn clippings, sweet potato and pea vines, green corn leaves, and the like.

Keep good-quality hay in the manger at all times. Cut the hay into 4" lengths. Legumes such as alfalfa, clover, vetch, and cowpea are more desirable than the carbonaceous hays like timothy, bluegrass, Bermuda, and similar grasses, although the latter are satisfactory if cut and fed when still green. Root crops, including carrots, turnips, and sweet potatoes, can be stored for winter feeding.

Regular feeding is important to keep the stock strong, so make sure that dry does, herd bucks, and developing breeding stock are fed daily the amount of grain or scraps that they will eat in a half hour or less. The young usually will start eating solid foods at three weeks, at which time both doe and young should get all the grain and scraps they can consume. When the litter is weaned, return the doe to the regular diet.

A diet for rapid growth of young rabbits, and for the doe until her young are weaned, should contain plant-protein supplements (soybean, peanut, or linseed) in meal, pea-size cake, or pellet form. Mix the supplement one part by weight with two parts of one or more whole grains. Be sure the items are well mixed. All grains may be used interchangeably, as their food values are about the same.

To kill a rabbit humanely, stun it by striking it with a stick on top of the head back of the ears. Suspend it head down and remove the head immediately to permit thorough bleeding.

In dressing the carcass, first cut off the tail and front feet. Remove the left rear foot at the hock joint, cut the skin im-

Hay for feeding can be cut into 4" lengths on a table having a backboard and a slot for a saw

mediately below the hock of the suspended leg, and open the skin inside this leg to the root of the tail. Extend this incision to the hock joint of the left rear leg and, after separating the edges of the skin from the flesh, continue pulling the skin off, leaving the fat on the carcass. After the skin has been completely removed, slit the carcass open along the belly and remove the entrails, saving the liver, heart, and kidneys. Cut off the right hind leg at the hock joint, and the rabbit is correctly dressed.

The expense of raising rabbits can be materially reduced by selling the pelts. While the skin is yet warm, place it flesh side out over a shaper and remove all wrinkles. The fore part goes over the narrow end, with both front legs on one side. Don't stretch the skin unduly.

The day after placing a skin on a stretcher, make sure that the edges of the pelt are drying flat and that the skin on the front legs is straight. Remove surplus fat. Hang the skin in the shade beyond the reach of mice. Should you store dry skins for an extended period, sprinkle them with naphtha flakes and pack them in a tight box. Never use salt. Furriers will buy pelts that have been kept in good condition, thus helping you to keep the cost of fresh Victory meat for your family at a minimum.

Above is a weaned litter busily feeding, while below are young rabbits in a hot-weather basket suspended to make the most of any cooling breeze

Below is an easy method of branding rabbits. An India-ink number inside ear identifies this Angora. Its valuable wool is plucked at regular intervals

Above, the completed bag ready for marketing. Drawing at right gives layout of the holes in the disks. The photo at extreme right shows bag being attached to disks with colored cord

Victory Shopping Bag Made of Fabric and Plywood

WITH some plywood, a piece of fabric, and the help of a brace and bit, anyone can make this victory shopping bag It holds a surprising number of packages and is designed to keep them from falling out at the sides.

Two 9/16" holes centered 3½" apart are bored in each of two disks cut from ¼" plywood. Eleven ⅛" holes are bored 7/16" in from the edge of each disk and evenly spaced, as shown. After sanding and varnishing the disks, paint on the V's and varnish again.

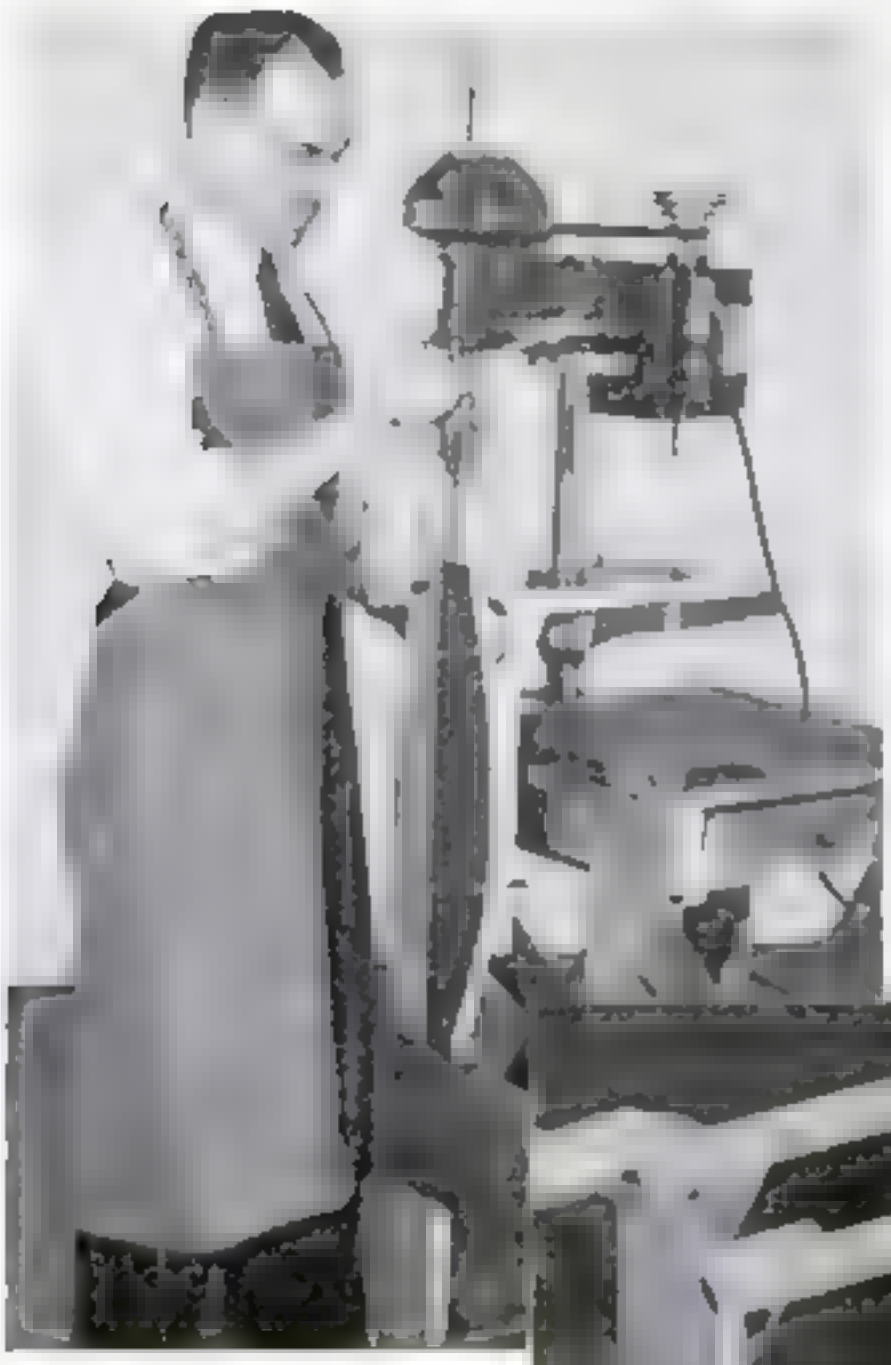
About ⅛ yd. of 30" wide fabric such as drapery cloth is required for the bag. All edges are hemmed, and the rectangle of cloth is gathered and laced to the small holes with colored cord. Seamed handles 1" wide, cut from the same material, are slipped through the large holes and sewed.

Ice-Cream Containers Are Used for "Candle" Centerpieces

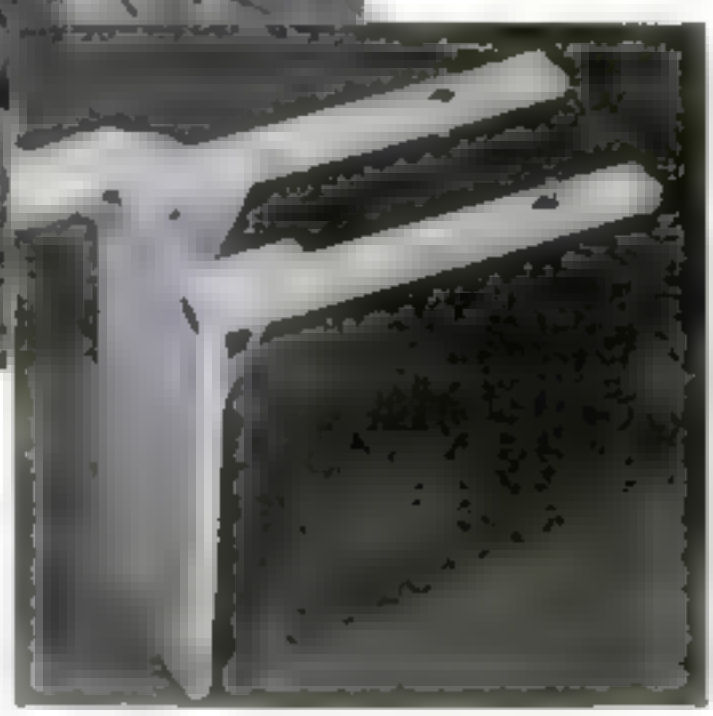
ICE-CREAM containers are easily transformed into make-believe candles which serve as attractive centerpieces for party tables and cost little or nothing to make. A patriotic motif can be added by making them red, white, and blue, but you can select any color combination you desire.

After removing the lids and inverting the containers, cover them with construction paper. Using the lid as a pattern, cut paper circles for the tops. Flames are fashioned from red cellulose film and glued to 1" lengths of pipe cleaner, which are inserted through holes punched in the tops. The pipe cleaner is secured by bending the inserted end. Leave a bit of it showing to represent a wick. Then tie a ribbon around each candle.

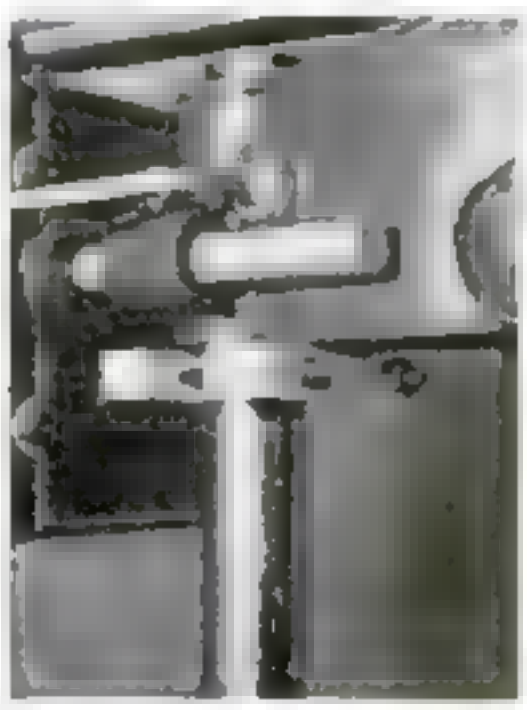
Small Drill Press Adapted to Bore Holes in End of Long Work



The work is clamped to a face held in a vertical position by two arms that are bolted fast to the drill-press table



At far right, the collar is shown bolted to the column

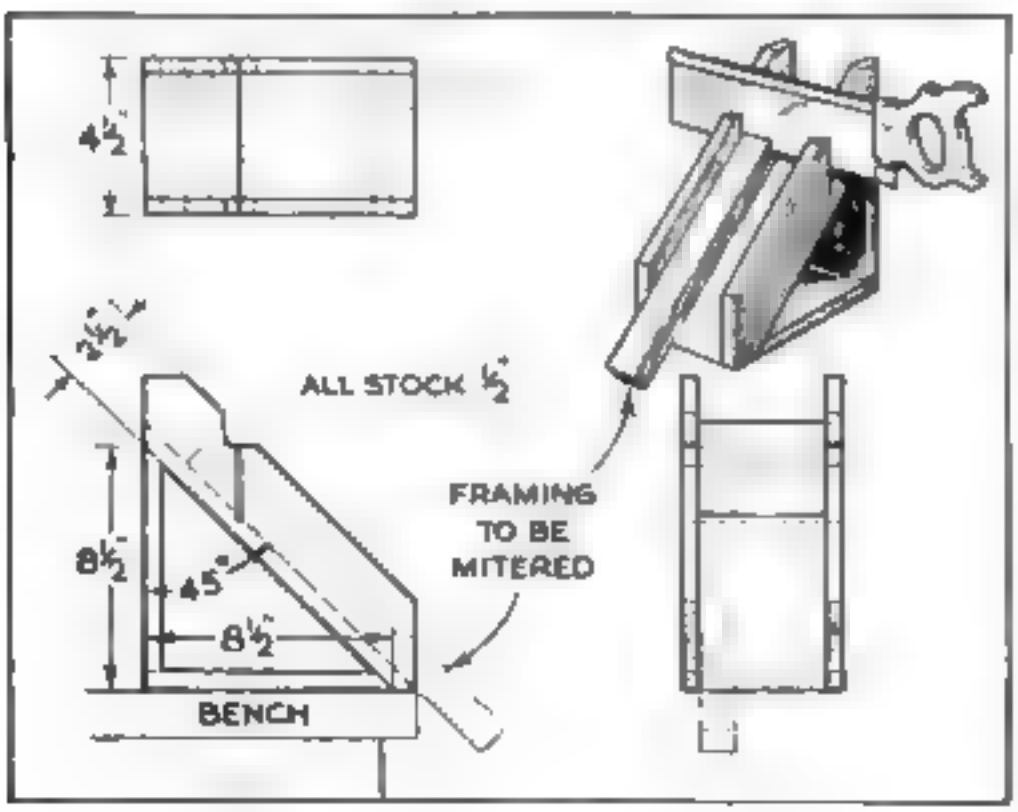


A SMALL bench-type drill press can easily be adapted to drill work longer than the maximum distance between chuck and table. Bolt the drill press at the extreme end of a sturdy bench that is itself bolted to the floor. The bench must not tip when pressure is put on the feed handle with the drill-press head turned to overhang the bench.

Raise the head to the top of the column and lock it there. Make a collar of two hardwood blocks rounded to fit the column and bolt them firmly around it just under the head. This will support the weight of the motor and head when the clamp is released to swing the head clear of the bench.

Construct a face of hardwood, to which the work can be clamped vertically for drilling, by fastening two arms of suitable length to a board by means of triangular braces. The arms are adjusted and fastened to the table by bolts.—BERTRAM BROWNOLD.

Wide Framing Mitered Accurately in Triangular Sawing Jig



CUTTING 45-deg. miters on wide boards can be done accurately with a narrow miter saw used in the triangular-shaped box shown at the left. It is designed to be attached to the edge of a bench so that the piece to be mitered can extend down below the bench.

The angle of the sloping bottom of the box, between the two sides of 2½" wide stock, is 45 deg. Both sides are notched to allow space for the thick back of the saw, and the slot in which the saw slides is vertical. The width of the box can be made to suit the length of the saw and the width of the piece to be mitered. A carpenter's steel square is helpful in getting true angles.—E. L. WESTDAL.

Shaping, Sanding, and Metal

In shaping the edge of an oval piece on the circular saw, keep the work pressed against a pencil mark above the arch in the fence. A molding head is mounted in place of the saw blade

Below, starting to cut a cove. The fence masks off the portion of the cutter not wanted. Be careful not to feed work too fast

By

EDWIN M. LOVE

A CIRCULAR saw is an invaluable piece of equipment for the home workshop because it not only makes sawing easy, but can also be used for shaping, jointing, sanding, and metal cutting. The accessories necessary for these additional tasks are comparatively inexpensive.

How can the saw be used as a shaper? A molding head fitted with interchangeable knives makes it a shaper. These heads are of several styles, some designed for the lighter uses to which home workshop equipment is generally put, and others for heavy-duty production work. The three cutters of a molding head are locked with screws in slots that are nearly at right angles to the radius, thus combining a shearing angle with safety. Solid two-winged cutters are available in a variety of patterns. They cost about the same as sets of cutters for a molding head and are very satisfactory.

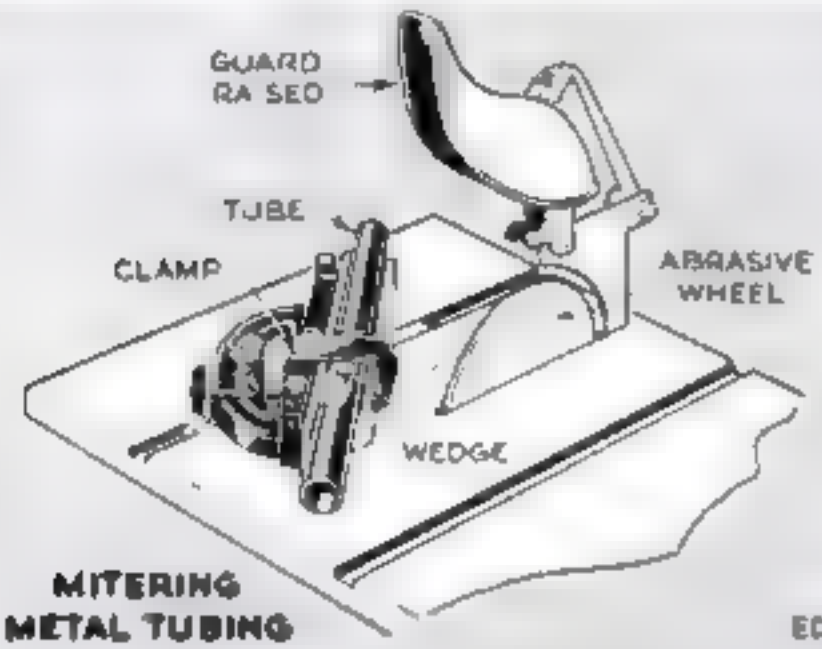
Mount the head on the saw arbor in the same manner as a saw blade. The dado-head insert serves in most cases, but sometimes a special wooden insert made to fit the job is better. As with a saw, the depth of cut is regulated by the distance the knives project above the table, and the width is determined by the position of the fence.

Straight molding cuts are made with the board lying on the table, or with the edges sliding on the table, according to the pattern of cut desired. If the fence has no built-in arch that will clear the molding head, screw on a wood face that has a segment cut from it. Adjust the cut relative to both table and fence,

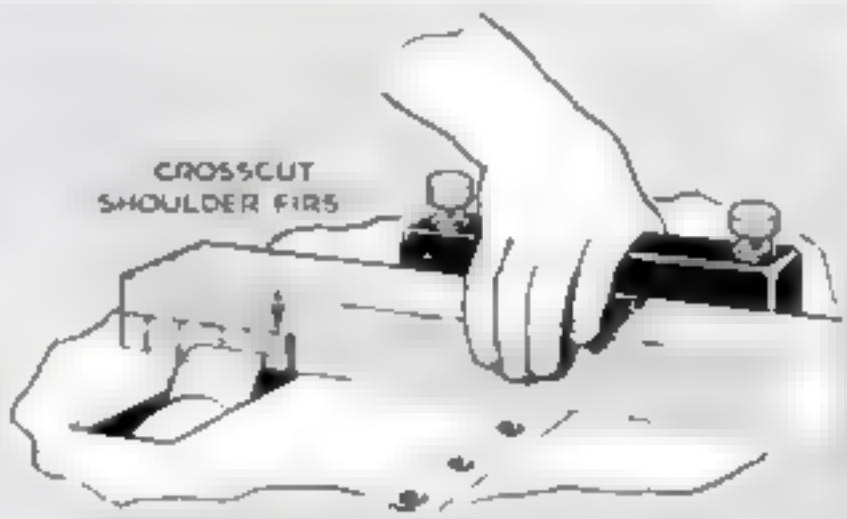
Cutting on the Circular Saw

and make a trial cut on a scrap of wood. When the setting is correct, pass the work over the cutters. Irregular motion may cause slight ridges, and feeding too fast leaves noticeable ribs. A better finish is usually obtained if a second pass is made without change of adjustments. If the molding extends around the piece, complete one end first, then one edge, next the second end, and finally the second edge. This enables the cutters to trim away the splintered corners left from cutting across the grain.

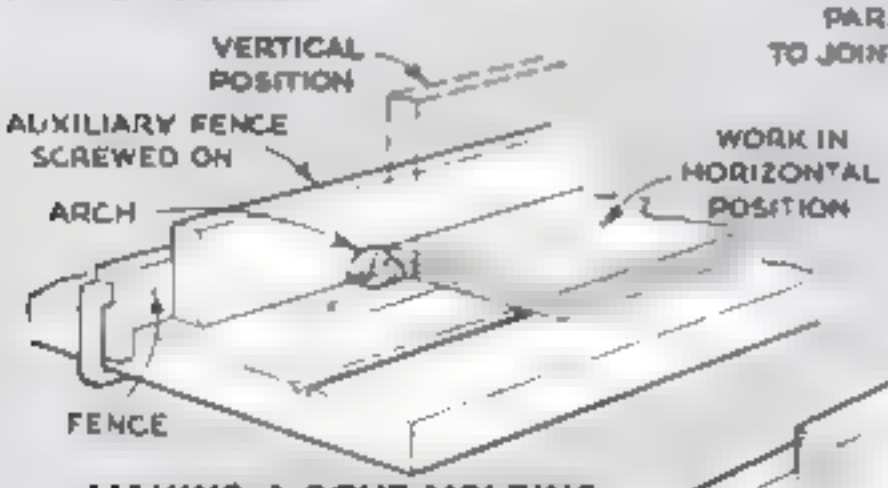
Can curved moldings be made on the circular saw? Outside curves are almost as easy to make as on a shaper. Feed the work against the molding head, keeping the edge against a center point marked on the fence above the arch. If irregularities appear due to shifting from the center line, a a second pass will smooth the work. When moldings require two or more settings, with or without a change of knives, be sure to



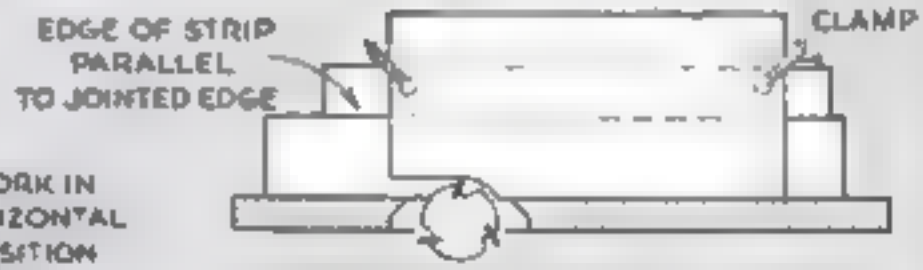
MITERING METAL TUBING



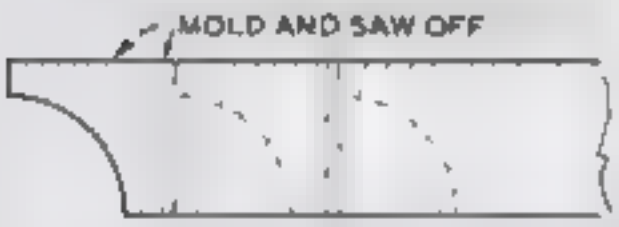
END RABBETS AND TENONS



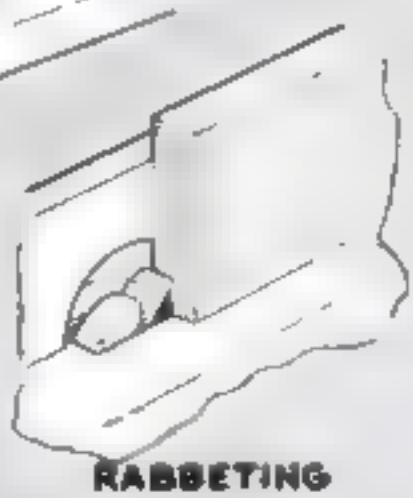
MAKING A COVE MOLDING

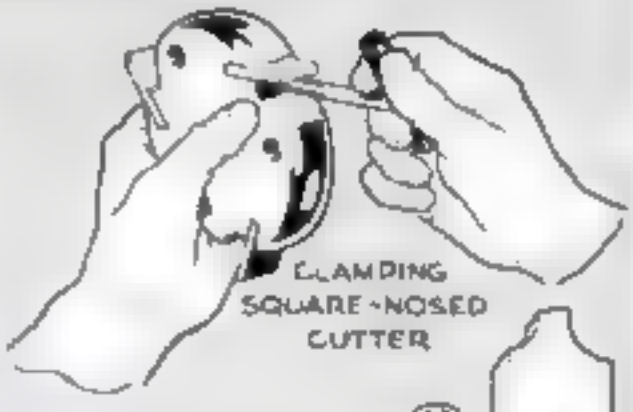


JOINTING WITH MOLDING HEAD



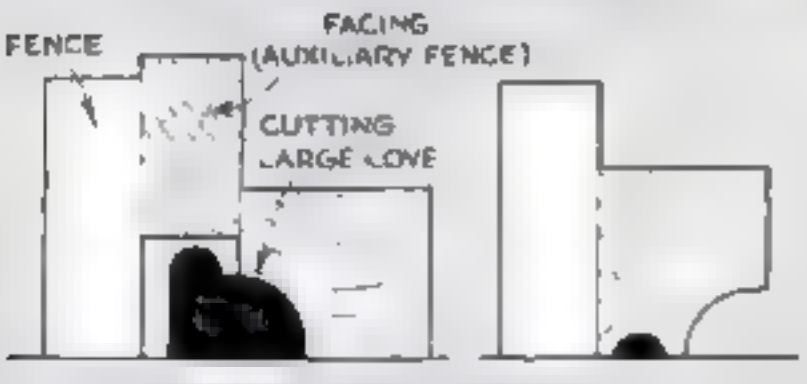
MAKING STRIP MOLDINGS


RABBETING

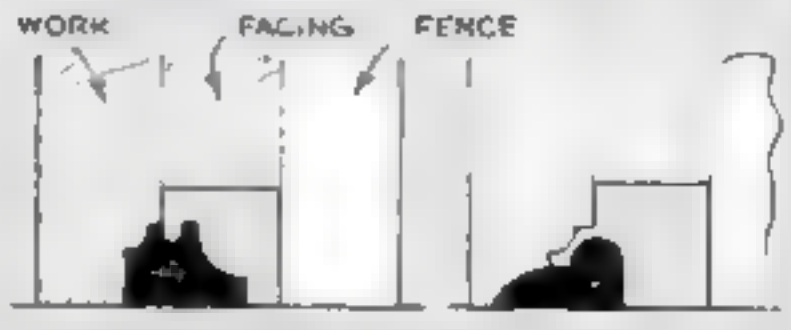


HEAVY-DUTY MOLDING HEAD


TYPICAL CUTTER WITH LOCK SCREW



DOUBLE-CUT MOLDING



DOUBLE-CUT MOLDING WITH TWO CUTTERS

Metal can be cut by using an abrasive disk on the arbor instead of the saw blade. Be sure to wear goggles, use the special iron guard designed for this purpose, and stand to one side. Cutting wheels of this type can do much damage if they are shattered

A grit-faced disk replaces the saw blade when the circular saw is used as a sander. Such a disk may be purchased or made up of plywood and coarse and fine garnet paper

make the successive trial cuts on the same trial piece of work, so that the finished sample will show how the work will turn out.

Inside curves can also be shaped, but only if they have very large radii.

How can jointing be done? Insert square-edged knives in the molding head, set the fence off center enough to allow for cutting the full width of the edge, and adjust the depth of cut to 1/16". The usual procedure is to pass the piece over the cutter as in making a molding, but since the edge in jointing is completely cut away, the support is gradually lost and gouging may result. A better method is to clamp a straight strip of wood to the side of the board parallel to the edge to be jointed. Slide this strip along the top of the fence or along a straight wooden facing if the fence is not true.

Rabbeting is simple. Shift the fence to expose the necessary width of cutter, and run the edge of the work over. The remaining flange carries the piece, thus preventing gouging. End rabbets and tenons can be cut as with a dado head. Crosscut the shoulders first to avoid splintering them.

Is the saw used for sanding? Special grit-faced disks designed for mounting on the arbor in place of a saw blade are available, but disks made of ¾" plywood with coarse garnet paper on one side and fine on the other work very well. If necessary, make a wooden insert for a plywood sanding disk. Most of the jobs that any small sanding disk can handle, such as dressing miter joints, shaping small blocks, and the like, are possible.

How is metal cutting done? Wheels used for cutting metal are made of emery or silicon carbide. They are about 3/32" thick and of various grits and bonds, according to the material which they are to cut. Before using such a wheel, examine it for cracks and chipped edges. Clamp it on the arbor with medium pressure, using a cardboard disk on each side to cushion it. An iron guard designed for the purpose also should be obtained. Stand aside when starting the wheel in case it should shatter.

The wheels cut steel amid a shower of sparks and leave precise, smooth surfaces, shearing through with ease. This method affords a simple way to cut sections from hardened steel without drawing temper to a great depth. The accuracy of work depends not only upon precision of measurement and clamping arrangements, but also upon the condition of the wheel itself. If it is out of round or chipped, it should be dressed true on the arbor to avoid wobble.

When mounted against a plywood disk for backing, cutting wheels can be used for surfacing, tool grinding, and similar operations.

Shown above is a sure method of jointing. Clamped to the work, parallel to the edge to be jointed, is a straight piece of wood that slides along the top of the auxiliary fence. Square-edged knives are used in a molding head. The fence is set off center far enough to allow for cutting the full width of the edge, and the depth of the cut is adjusted to 1/16". Cut end rabbets and tenons as with dado heads

Moldings can be cut on outside curves almost as easily on a circular saw as on a shaper, and the operation is similar. A round piece is being molded in the photograph below, with the help of a notched fence used as a guide

There's a Way to Sharpen Each Blade of Your Pocketknife

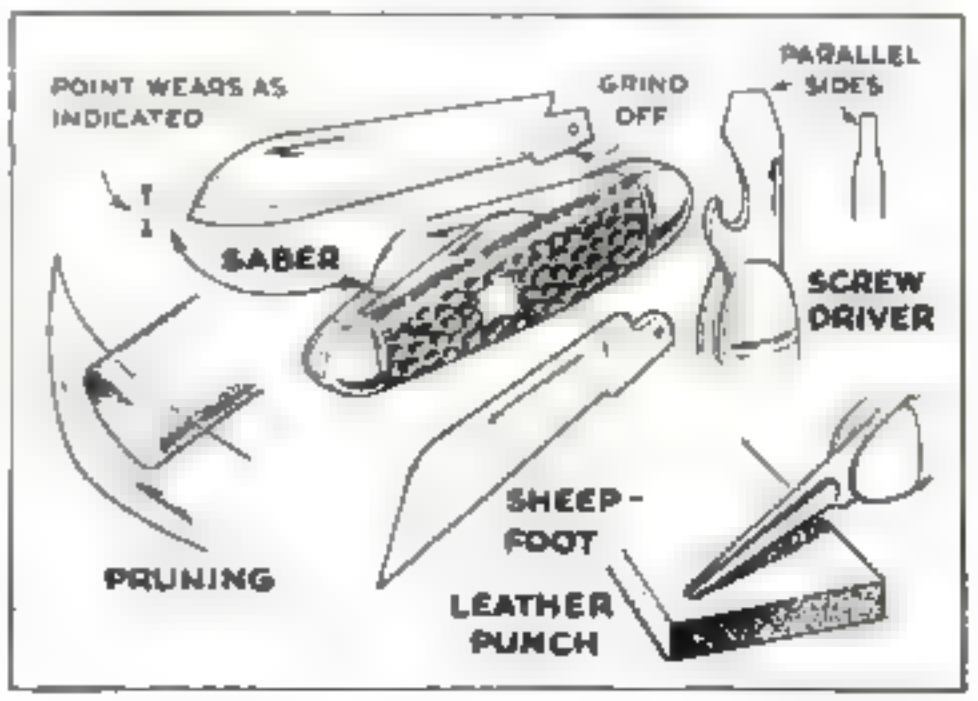
ROUGH down a dull pocketknife blade on a coarse oilstone and finish the whetting on a fine one. A razor hone is good for finishing. Rest the stone on a workbench or clamp it in a vise. Wet the surface with water, light oil, or kerosene. Incline the blade about 20 deg. and make long, oval strokes with even pressure, drawing the blade from heel to point. Change from one side to the other to equalize the bevels. The blade's wire edge can be taken off with light diagonal strokes toward the edge. Touch up the other side and finish on a finer stone.

To whet a blade of the saber type, sharpen the straight section and hone the point with rocking strokes that bring every part of the curve to bear on the stone. Keep the edge of a sheepfoot blade straight; otherwise the advantages of this shape are lost. The concave edge of a pruning knife is honed on an oval-shaped abrasive stick or slip stone. Sharpen a leather punch nearly at right angles to the stone, later removing the wire edge with a triangular slip stone. Keep the sides of a screw driver parallel.

Some mechanics prefer to sharpen a knife from one side only. This has certain advantages in difficult whittling projects. If a pocketknife has two or more blades, one may be whetted in this way. Whet the flat side lightly to remove the wire edge.

Grinding should be necessary only if the edge is very blunt, or to make the heel narrower. A sudden flush of blue means that the temper is lost at that place. Use a grindstone rather than an emery wheel if one is available.—E. M. L.

Moments spent in whetting the edge of a knife will pay dividends in time saved and better work



PAPER-WEIGHT PUP
Whittled with a Penknife

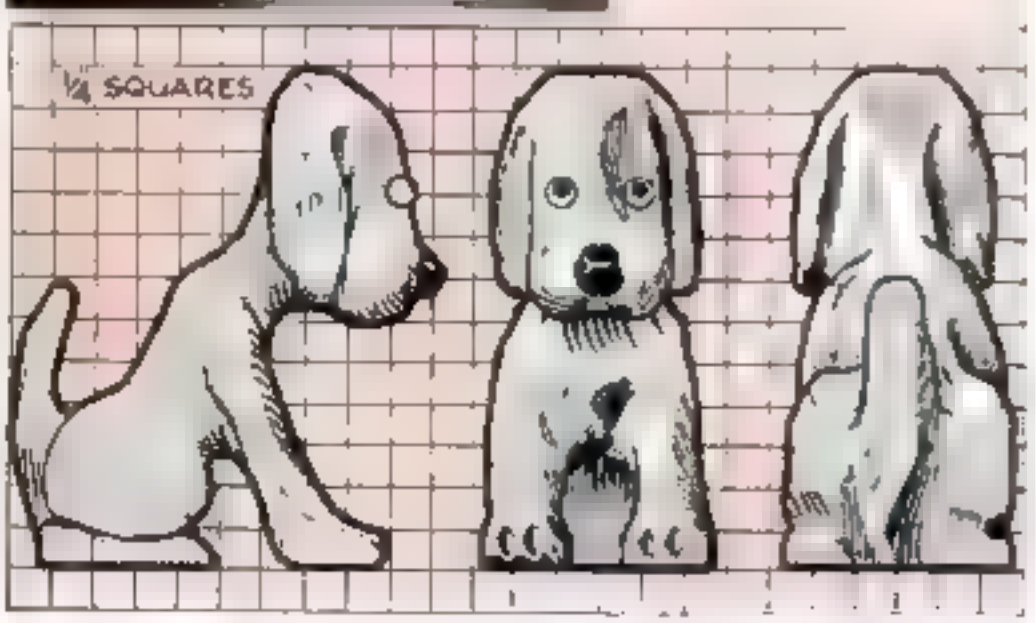
By ELMA WALTNER

PETEY, our jaunty pup paper weight, does a good job of keeping the papers on your desk from blowing off in each gust of wind. He'll be popular with visitors, too.

Petey is roughly carved, a fact that adds to his charm and to your ease in shaping him.

The drawings grouped around the photo below show him from three different angles. After some practice you may want to try a different pup, perhaps one with short ears and tail as shown at the right.

Make the pup from any soft wood—a scrap of redwood or soft pine works easily and takes a nice finish. Lay out the profile pattern on a block 1½" by 2½" by 3". The grain should run vertically to give strength to his front legs and head. Saw out the profile with a coping saw or on a jig saw. Drill several holes through the wood that is to be cut away between the front legs. This makes shorter work of the carving.



A sharp jackknife is the only tool you need for shaping the pup. Turn the work often in carving, for this makes it easier to get the proportions correct.

The carving finished, sand down any rough spots. But don't be so enthusiastic in your sanding as to take off all the angles, for they add to Petey's individuality.

If you use redwood, a coat of shellac is all the finishing necessary. If pine is used, you'll probably want to apply a coat of mahogany stain. The eyes are white map tacks with black painted pupils; the nose is painted black, and the mouth red.

Turn the base 2¾" in diameter and 1½" thick. Make a shallow recess in the bottom to hold the weighting material. Lead shot or coarse sand may be used for this. Then turn out a thin disk of wood to fit the bottom of the recess. Glue this into place after the weighting material has been put in. Almost any wood will do for the base. In this case ordinary red cedar was used. Finish with two coats of shellac and wax.

Mount the pup on the base with glue and dowels, and he will be ready to do his small part in keeping your desk tidy.

Lay out on squares the profile at the extreme left or one of your own design. Transfer it to a wood block, saw to the outline, and carve

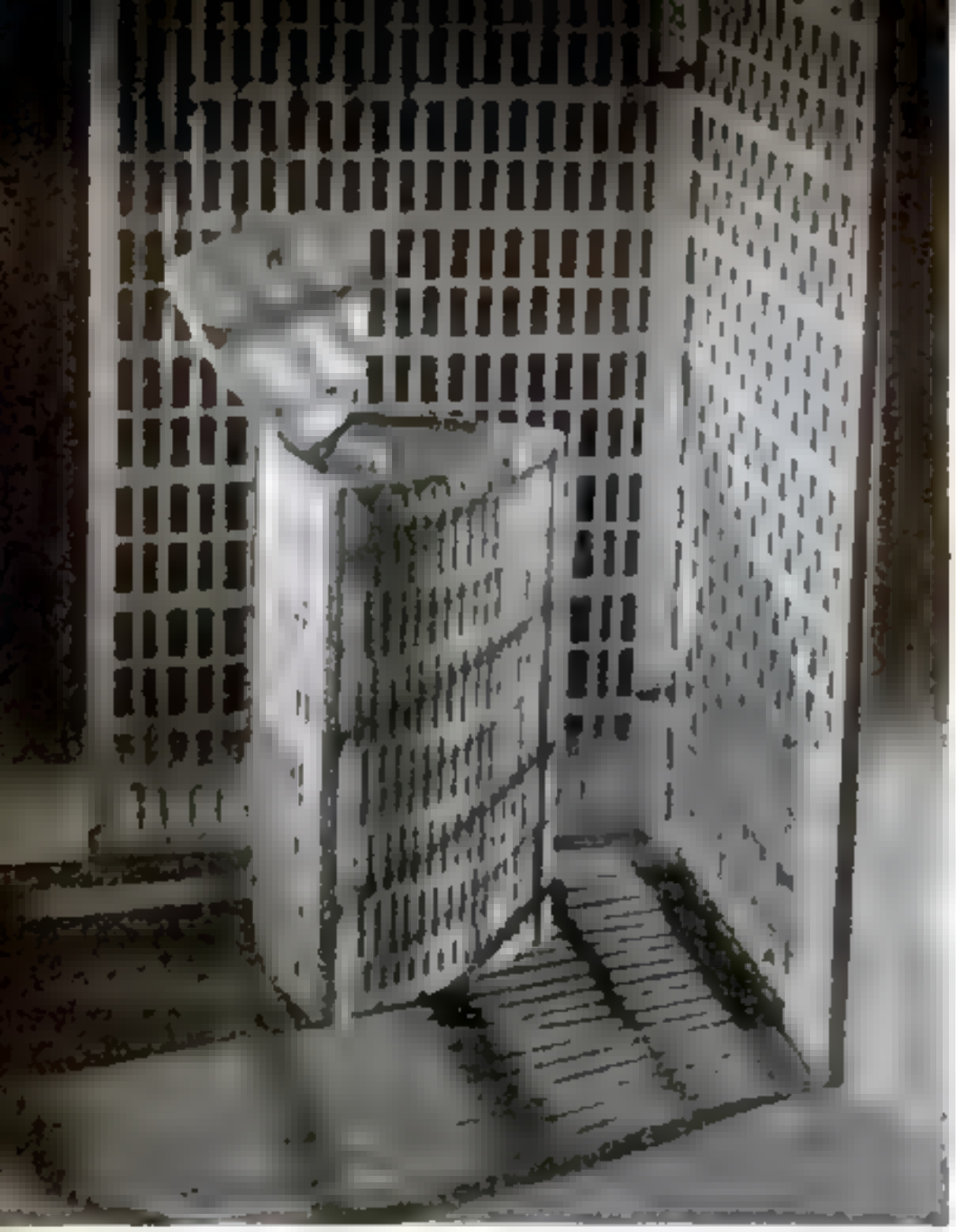
Dear Workshop Editor.

Some dance-band drummers are using tom-toms with great success. These drums have a rich, deep, resonant bass with plenty of carrying power. Could you publish plans showing how to make a tom-tom? Maybe one could be built from part of a small barrel.

L. R. III New York N. Y.

A rejected skin (one that has been poorly tanned) may be bought from a tanner. Goat, cow, calf, and deer hides are best

This unique method of using a barrel to make a tom-tom was worked out by Arthur M. Chase



Working

THREE CRAFTWORK

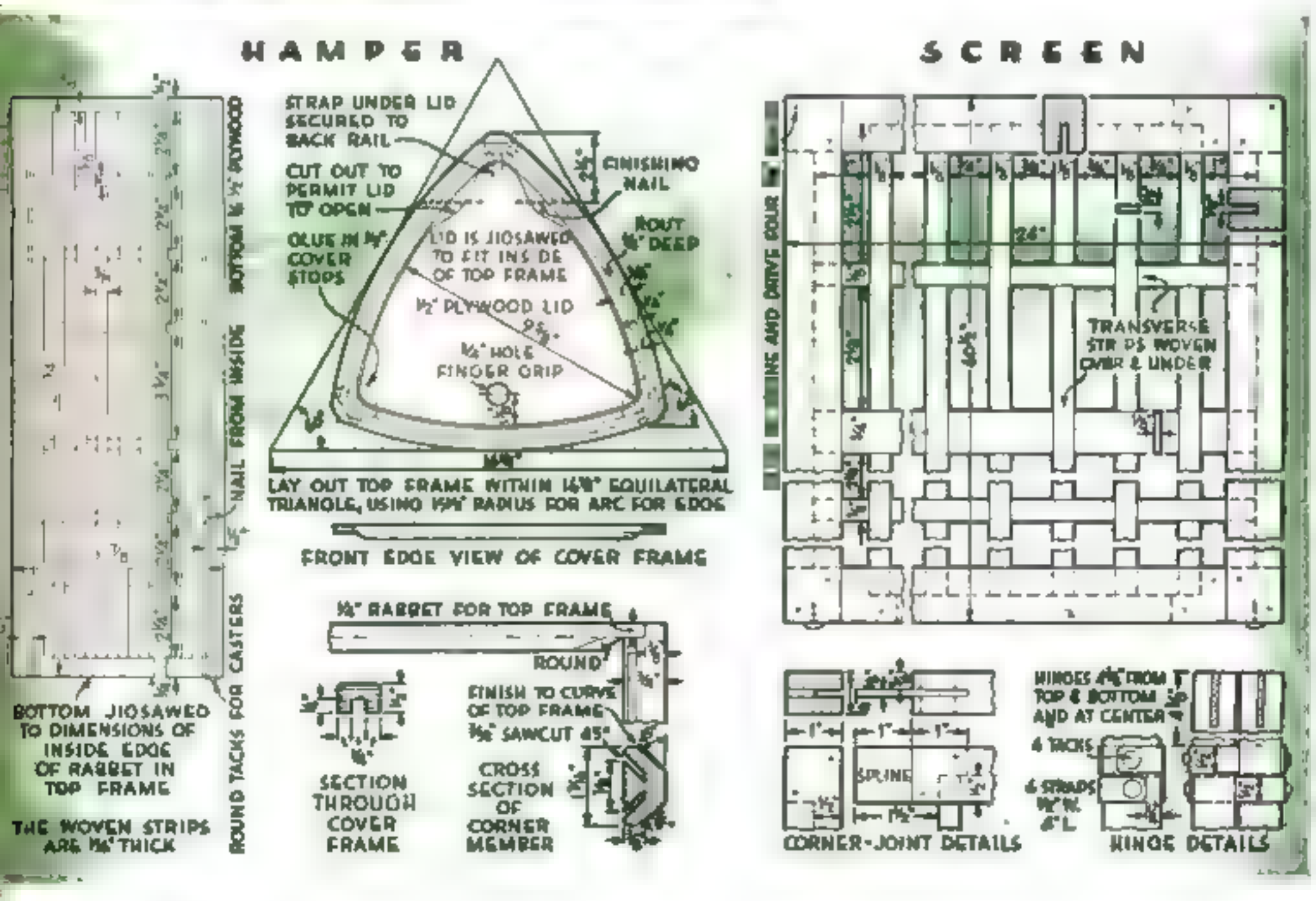
Designed by

Ernest R. Dewalt

DECORATIVE SCREEN. This is an interesting project in woven wood. Rip scraps for the two panels into ⅛" thicknesses and three widths as indicated in the drawing. Longitudinal strips are cut 59½" long and transverse ones 23" for the screen shown. Pine was used for all parts, but any wood will do.

Weave the panels square, using two lines at right angles on a piece of wrapping paper as a guide. Two wood strips based along the lines will be helpful. Spacers of wood or cardboard will save time.

Groove all frame members at the same saw setting; then saw the ends for splines as shown. Assemble the long members and the



Time: Two Evenings

PROJECTS THAT MAKE THE MOST OF LITTLE MATERIAL

panels first, gluing in the splines and fastening with ⅝" brads at the splines and wider transverse strips. Apply two coats of white shellac or varnish. When the finish is dry, attach the leather hinge straps in pairs as shown. Working time: 5 hours.

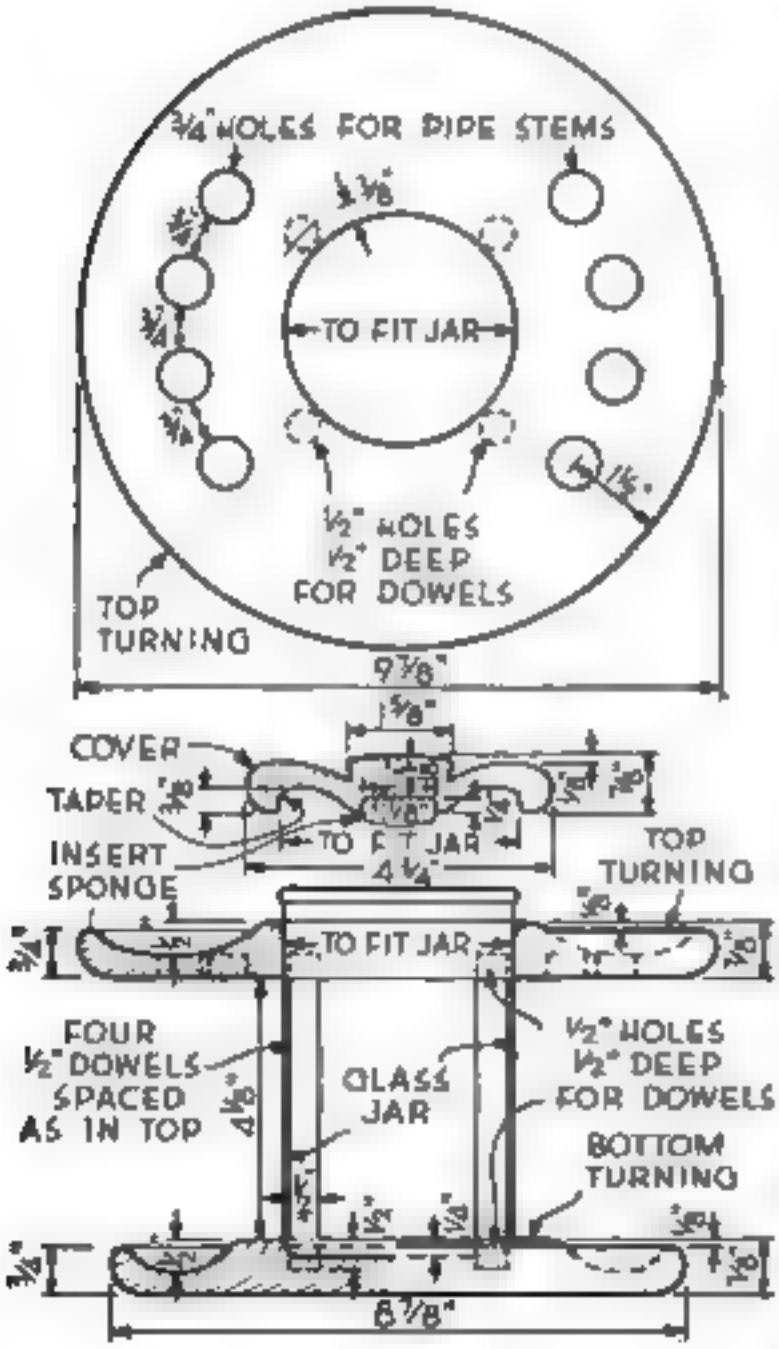
WOVEN HAMPER. Scraps are also put to work in weaving the three panels of the triangular clothes hamper on the facing page. All of these strips are 1/16" by ⅝" and are woven as shown in the drawing.

Shape the corner rails from ¾" pine and cut grooves to receive the panels, which are curved to form a rounded triangle. Nail the panels in place from the inside. Lay out the top frame on ½" plywood; then rout out a ¼" groove for the top of the panels. After a trial fit, join the frame to the end rabbets of the corner rails with glue and nails.

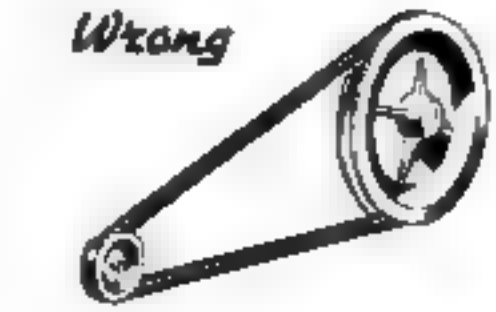
To form the lid, simply shape the back end of the plywood cut from inside the top frame. A hole is bored for a finger grip, and the lid is drilled transversely with undersize holes for two clipped finishing nails that form the hinge. The bottom is sawed from plywood, the panels being nailed to it and overlaid with 1/16" by ¾" strips held by roundhead tacks. Finish like the screen. Working time: 5½ hours.

HUMIDOR AND PIPE RACK. Here is a dual-purpose project that will delight any pipe smoker. Obtain a glass jar that will hold ½ lb. of tobacco and supply the missing dimension in the drawing to fit it.

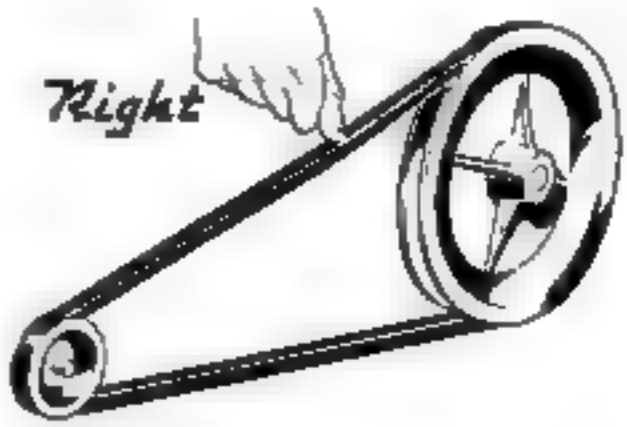
The upper section and bottom of the rack are turned from mahogany, as is a new top for the jar. Line up and bore the holes for the dowels, and drill pipe-stem holes in the upper section as shown. Finish with three separate rubbed coats of thin, clear shellac or varnish before gluing in the dowels; then insert a small humidor in the cover. Working time: 4½ hours.



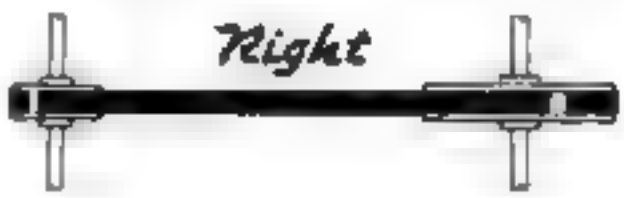
HW 215



Large pulleys provide greater driving pull with normal belt tension. The extra tension needed to prevent slippage on small pulleys overheats a belt



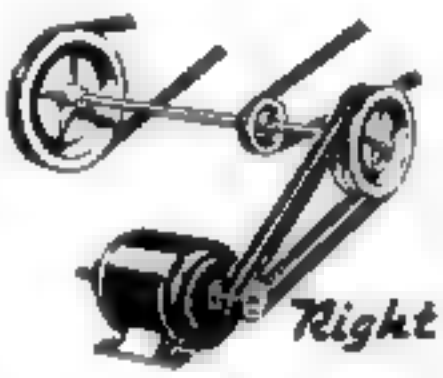
Be sure that both shafts and pulleys are aligned. Improper alignment of either causes excessive side wear on a belt and will result in a rupture



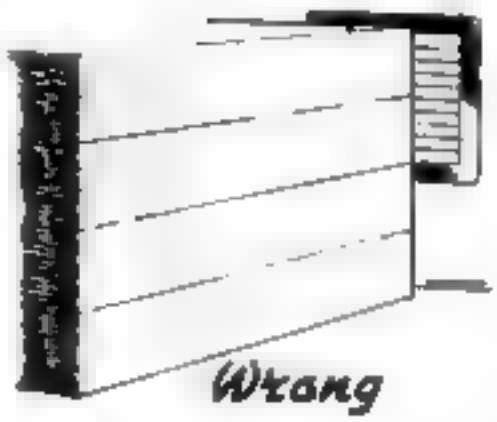
Longer Belt Life

ECONOMICAL use of belts in the shop means longer service from them and considerable saving in money and material. Always run belts at recommended speed. All belt-and-sheave combinations have a specific speed at which centrifugal force tends to throw the belt away from the groove, causing loss in transmitted horsepower.

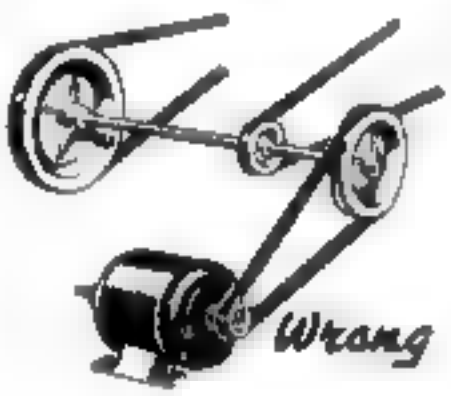
It will pay also to use a sufficient number of belts on each drive to meet the power requirements of your machines. You will find it far better to overbelt than to underbelt. For example, using four belts on a drive requiring five reduces belt life about 60 percent. These drawings show other points to watch.—J. MODROCH.

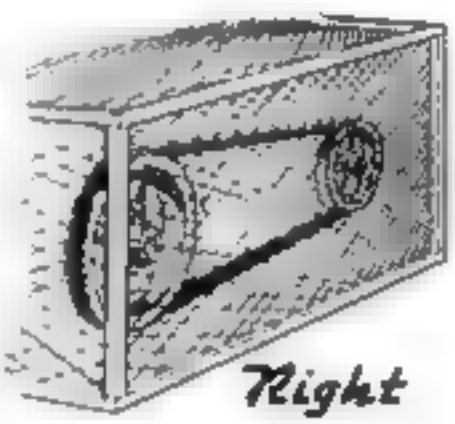


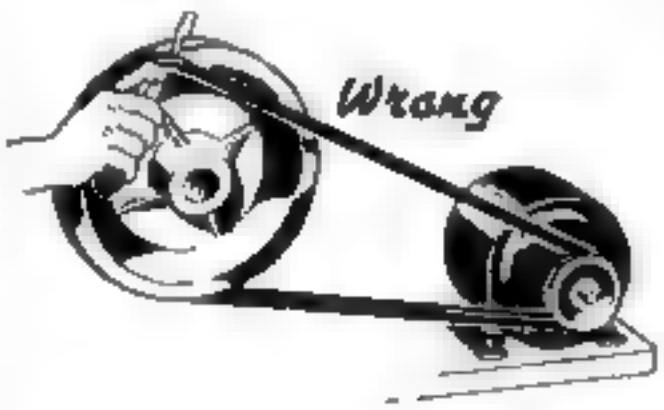
Never put too much load on a belt. Two machines driven simultaneously at full load always require an extra primary belt



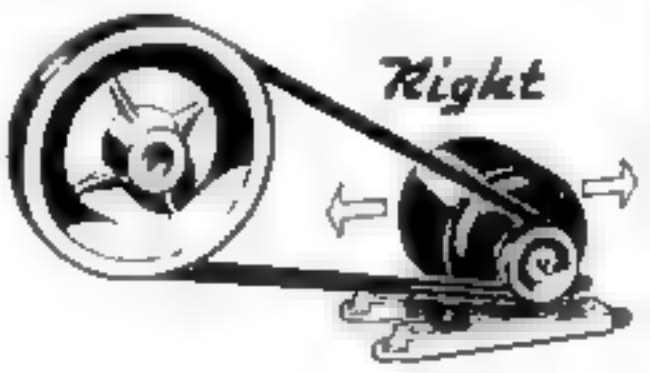
Run belts cool and dry An unventilated guard, excessive moisture, or heat makes the rubber in a belt hard and brittle

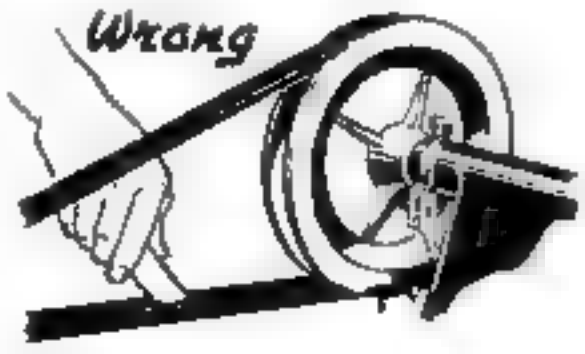




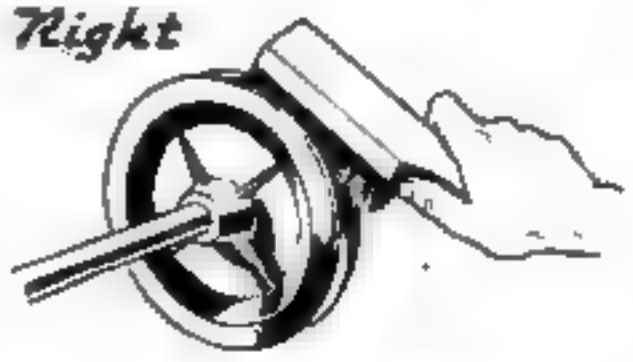


Prying a V-belt over a pulley rim may rupture it. If required tension does not permit the belt to be put on by hand, a slotted mount will allow the motor to be slid in for installing the belt



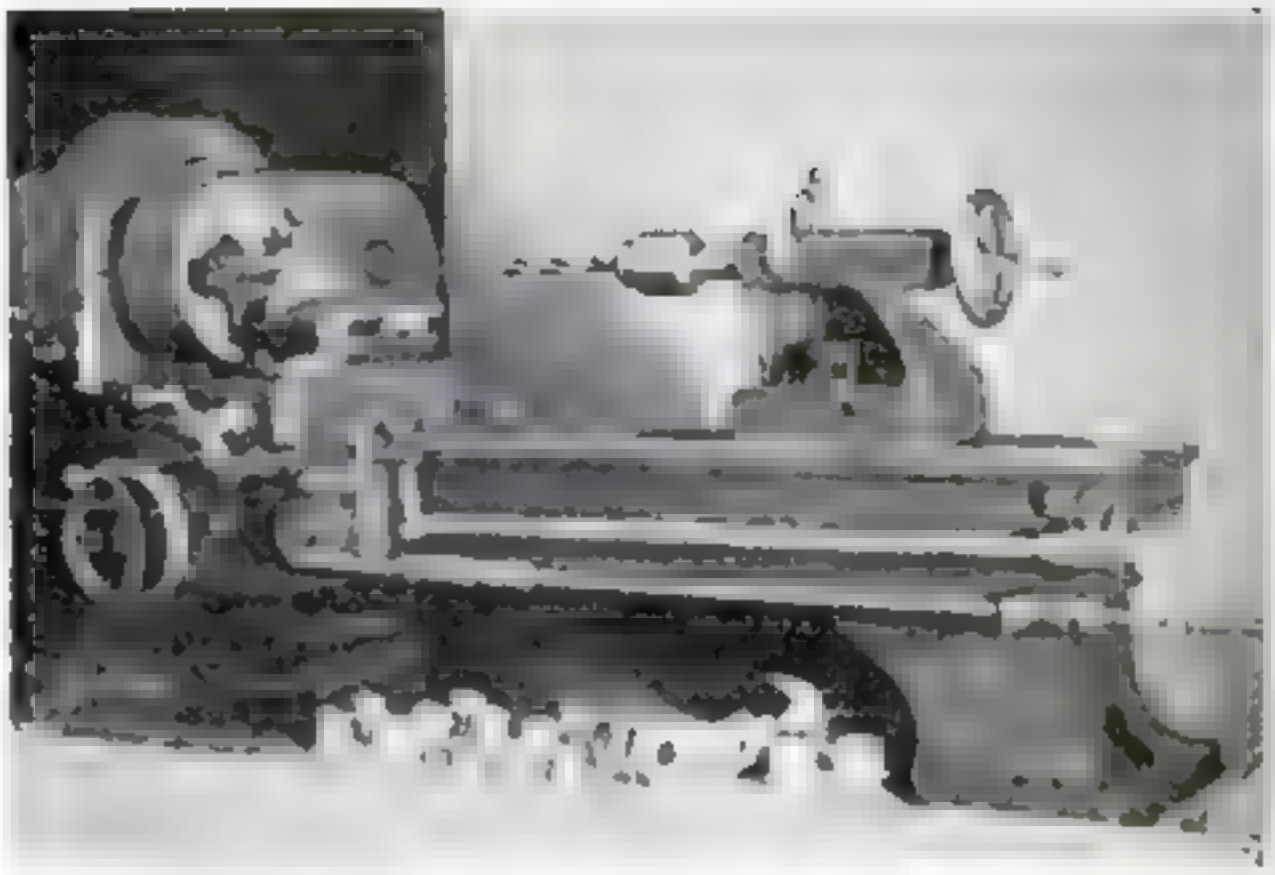


Lubricate bearings, but keep oil off belts, and don't use dressing on a V-belt — adjust tension instead. Dirt in grooves wears away belt rubber



Wm. Patrick

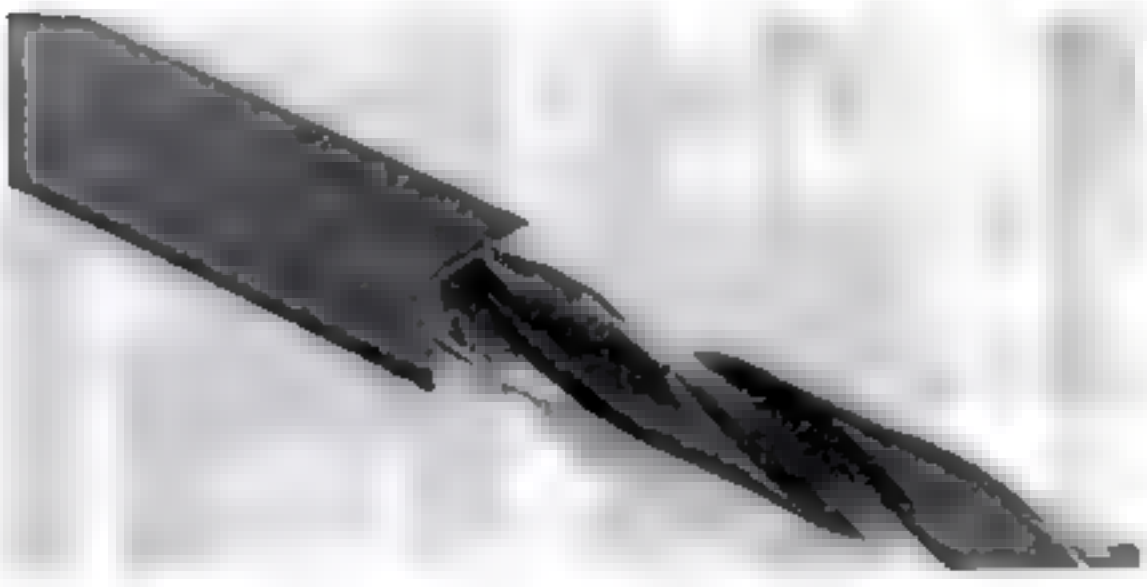
NEW SHOP IDEAS

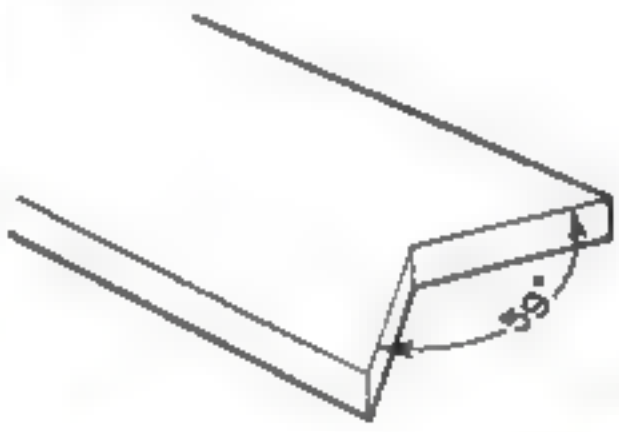


SEPARATE STOPS can be set for multiple-tool operations in bench-lathe production work with the ingenious device shown on the lathe at the right. This carriage stop consists of a threaded cross bar having adjustable nuts to control the length of the cuts and appropriate connections for disengaging the carriage feed. It automatically stops the carriage without shutting off power as each tool in the tool-post turret finishes its work, thus releasing the operator for other jobs or for simultaneous drilling and similar tailstock operations.

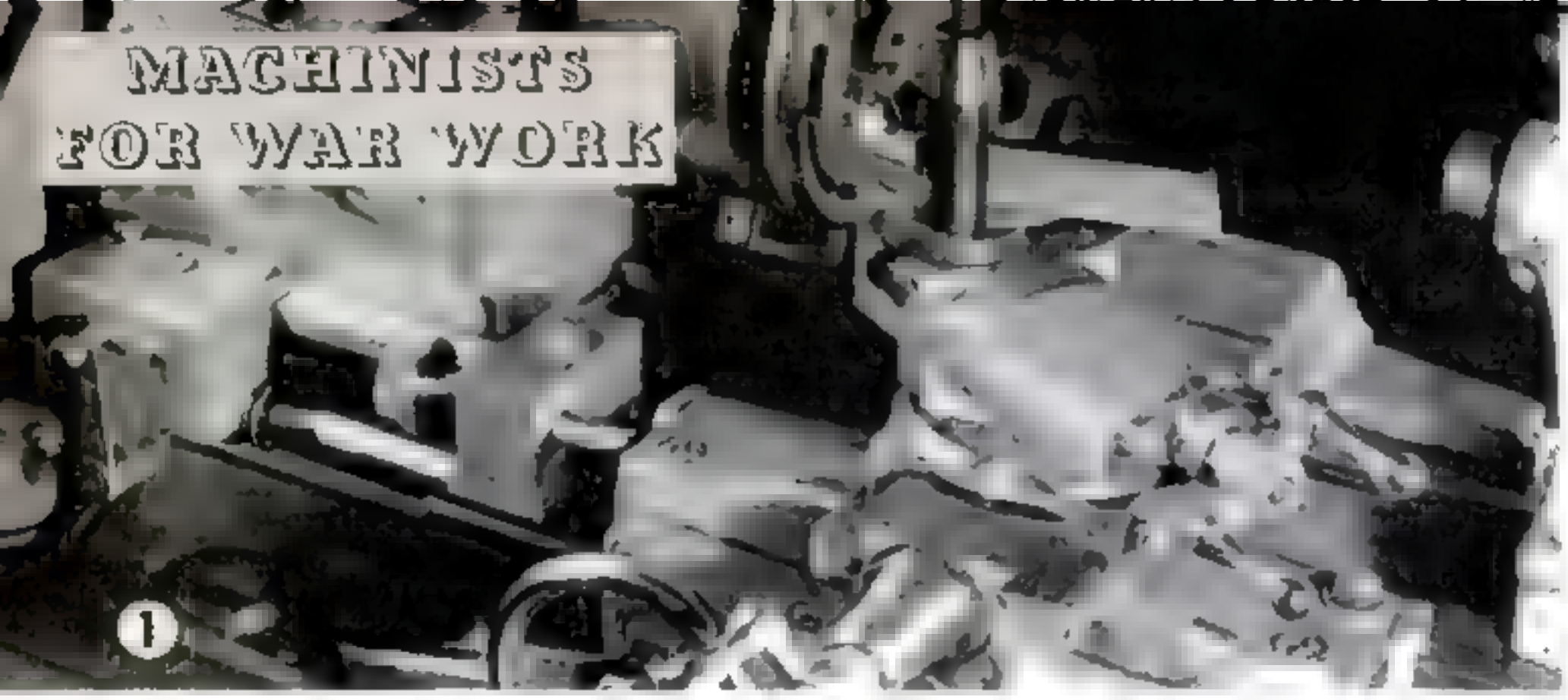
The stop was invented by David I. Welt, owner of a New York City shop engaged in war work, when he was faced with turning out a large number of identical parts with all of his available machines. In addition to speeding the job, it reduced work spoilage, tool breakage, and danger to the operators.

TWIST DRILLS MAY BE SHARPENED accurately with the help of a drill-point gauge made as shown below from a scrap piece of 1/16" or ⅛" cold-rolled steel. Be sure to file the point angle on the gauge accurately to shape. This angle depends to a large extent on the material to be drilled, but 59 deg. has been found most satisfactory for average work. Both cutting edges of the drill should be ground to the same angle, since a difference will cause one lip to take a larger cut than the other and make the drill cut oversize to some extent.



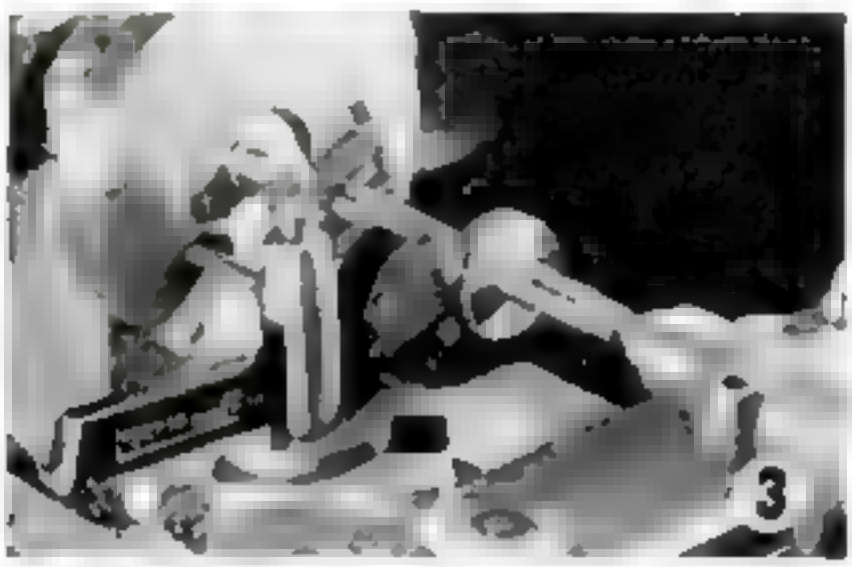


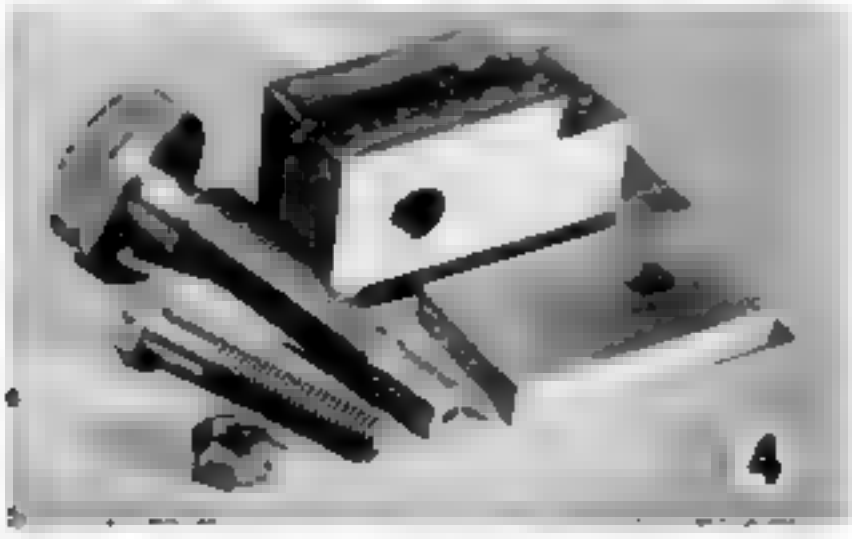
NONTOXIC HAND CREAM, used frequently by machinists to protect their hands against the action of soluble-oil cutting compounds, will also keep the fingers from leaving perspiration marks that might cause the rusting of precision parts or specially finished metals. The cream is spread on the hands before work is begun and can be washed off easily after it is finished. A companion product is a water-soluble rust-preventive liquid that may be applied to metal parts by dipping, spraying, or brushing. It is noninflammable and also nontoxic.



SHOP ACCESSORIES

You Can Turn Out from Scrap Stock





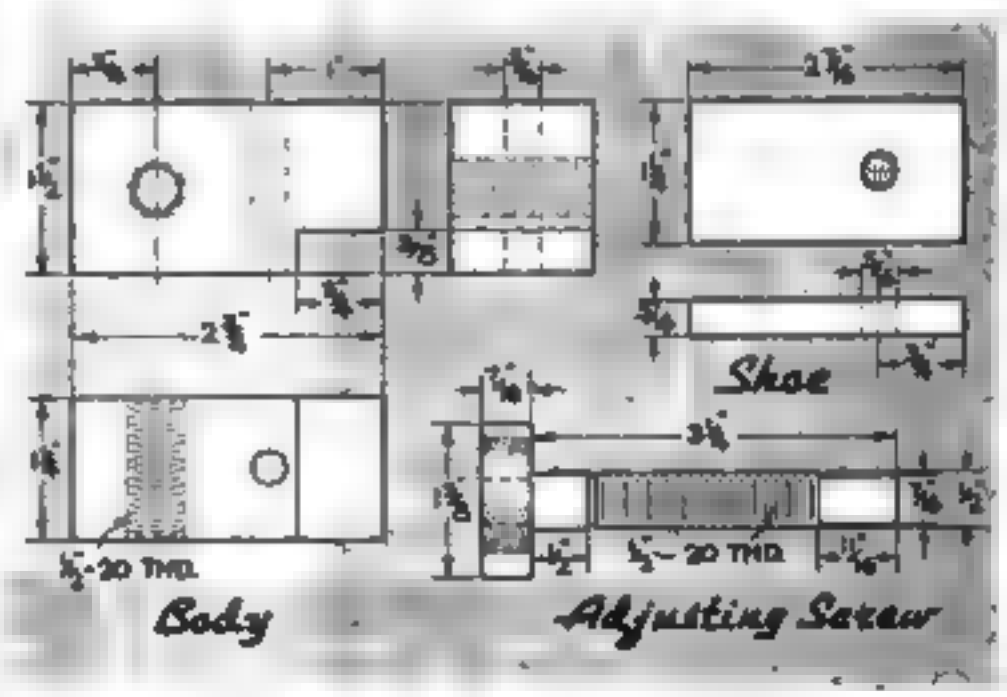
Odds and Ends of Steel Used to Make Lathe Carriage Stop and Depth Gauge

By C. W. WOODSON

TWO accessories any machinist will find useful are a lathe carriage stop and a depth gauge. Although these may not be available on the market today, it is possible to make both from scraps of steel such as can be found in any shop.

LATHE CARRIAGE STOP. A carriage stop is especially useful in production work or when duplicate parts are to be made. It is clamped to the front bedway of the lathe on either side of the carriage and may be set to limit tool travel at any point along the bed. An adjusting screw makes it possible to control the depth of boring or facing cuts, cut off work at a given point, or duplicate longitudinal cuts. Since the stop is not designed to shut off the power feed, the carriage should be fed in *by hand* for the last part of the cut.

The stop shown in use on a lathe in Fig. 1 was



made from short ends of cold-rolled steel. A block, which forms the body, was first drilled for the clamping and adjusting screws, the hole for the latter being tapped ½"-20. One end was stepped in the shaper (Fig. 2) to fit the flat top of the front lathe way. If the lathe on which the stop is to be used has V-ways, the block should be shaped accordingly to fit.

To prevent scratching or marring of the lathe way, the contacting surface of the block was carefully polished.

For clamping the carriage stop in place, a shoe was cut from bar stock to the dimensions in the drawings and drilled at one end to receive the clamping screw.

A disk hand wheel for the adjusting screw was drilled to fit a mandrel, on which it was turned to size and knurled as in Fig. 3. The screw was turned from a ½" bar, one end being shouldered to fit the disk, and then threaded in the lathe. Riveting the screw and disk together completed the job. All parts are shown in Fig. 4, along with a cap screw and nut, which are used for clamping the attachment to the lathe.

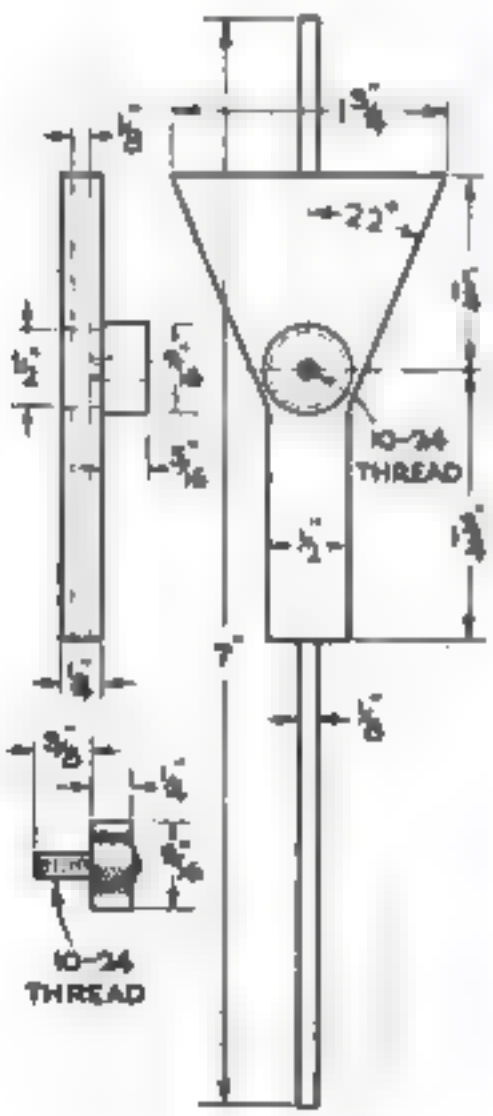
DEPTH GAUGE. Used in connection with a machinist's rule, this adjustable depth gauge (Fig. 8) is convenient for measuring recesses in dies, dimensions from plane surfaces to projections, the depths of holes, and so forth.

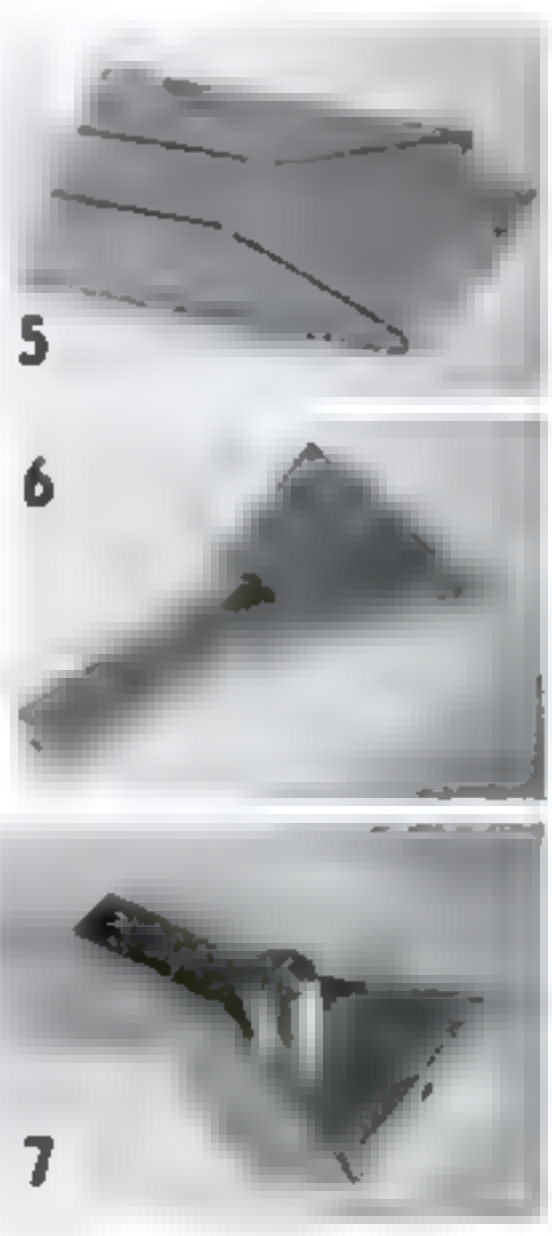
The body was sawed out of a ¼" by 1⅝" by 3" piece of cold-rolled steel (Fig. 5). It was draw-filed bright all over and the edges were filed smooth. Next, the ⅛" hole for the adjustable rod was laid out, center-punched at both ends of the piece, and drilled. This was done in the lathe by supporting one end of the work on the tailstock center, which aligned the work more accurately than could be done in a drill-press vise. The hole was drilled halfway through from each end with a No. 31 drill, then opened out to ⅛" by running the drill right through from one end to the other.

Another hole was drilled through the face of the work 1⅛" from the wide end, as shown in Fig. 6, for the boss. The latter was turned with a shoulder to fit the hole, riveted in place (Fig. 7), drilled with a No. 25 drill, and tapped 10-24 as shown in the drawings. Then the ⅛" drill was run through once more to continue the lengthwise hole through the shoulder of the boss.

The thumbscrew was made by knurling the end of a short steel rod, which was then turned to size, threaded with a die, and cut off. With the piece reversed in the chuck, the threads being protected by heavy paper, the top was turned to shape and polished with emery cloth. A 7" length of drill rod, turned accurately square on the ends, formed the adjustable rod.

If etching or engraving facilities are at hand, the rod may be marked with any sort of scale desired.

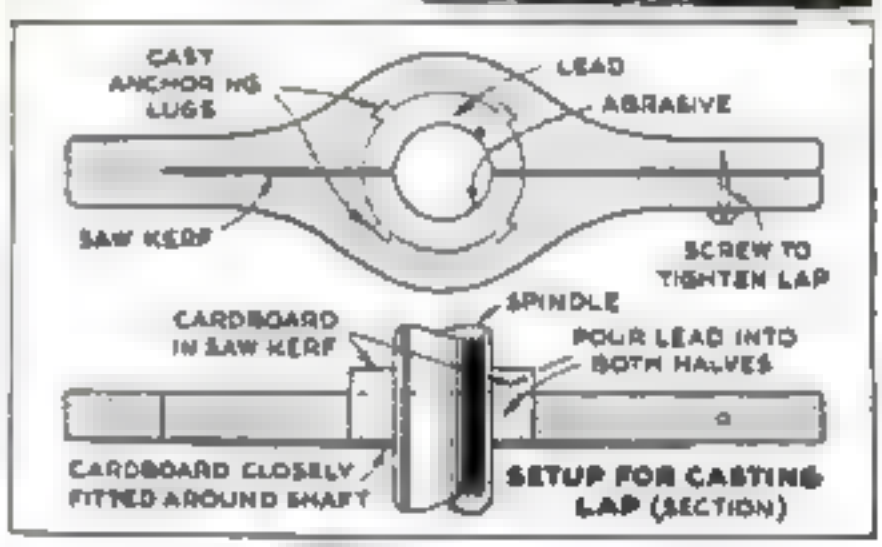




Lathe Spindle Trued with Lead Lap

ONE way to true a lathe spindle or other shaft worn out of round is to lap it with aluminum oxide grains or other abrasive and oil. The body of the lap is cut from wood stock. Although the lap shown in the photo below was about 1" thick, a thicker one may be used to advantage if the length of the bearing surface to be trued permits. Cast the lead around the spindle, set up as shown in the accompanying drawing. For lapping, mount the spindle to revolve on a brass rod held in a vise on the drill-press table. In the spindle taper, insert an arbor having a projection about ½" in diameter that can be gripped in the drill-press chuck. The press should be operated at a speed of about 300 r p m.—WALTER E. BURTON.

The lap is slotted and has an adjusting screw, as shown in the drawing below. Notch the hole to form anchoring lugs on the lead insert at the time it is cast



Eyeglass Case Holds a Micrometer

A MICROMETER of the 1" size can be kept safely in an ordinary eyeglass case. The felt or plush lining usually found in these cases affords extra protection for this sensitive precision tool, and there is less danger that it will be mislaid or damaged in the shop. If the case happens to be slightly too small, it may easily be enlarged by prying open the lip against which the lid closes. This will widen the case a trifle without impairing its usefulness.—JACK J. SNYDER.

Corrugated Cardboard Linings Improve Cabinet Drawers

SHOP-CABINET drawers which are used to hold small articles such as drill bits, nails, screws, and the like may be improved by lining the bottoms with corrugated cardboard. These corrugations, placed uppermost in the drawers, form little hills and valleys that reduce the tendency of small objects to roll or shift when the drawer is moved. The corrugations can be placed either crosswise or lengthwise.—W. E. B.

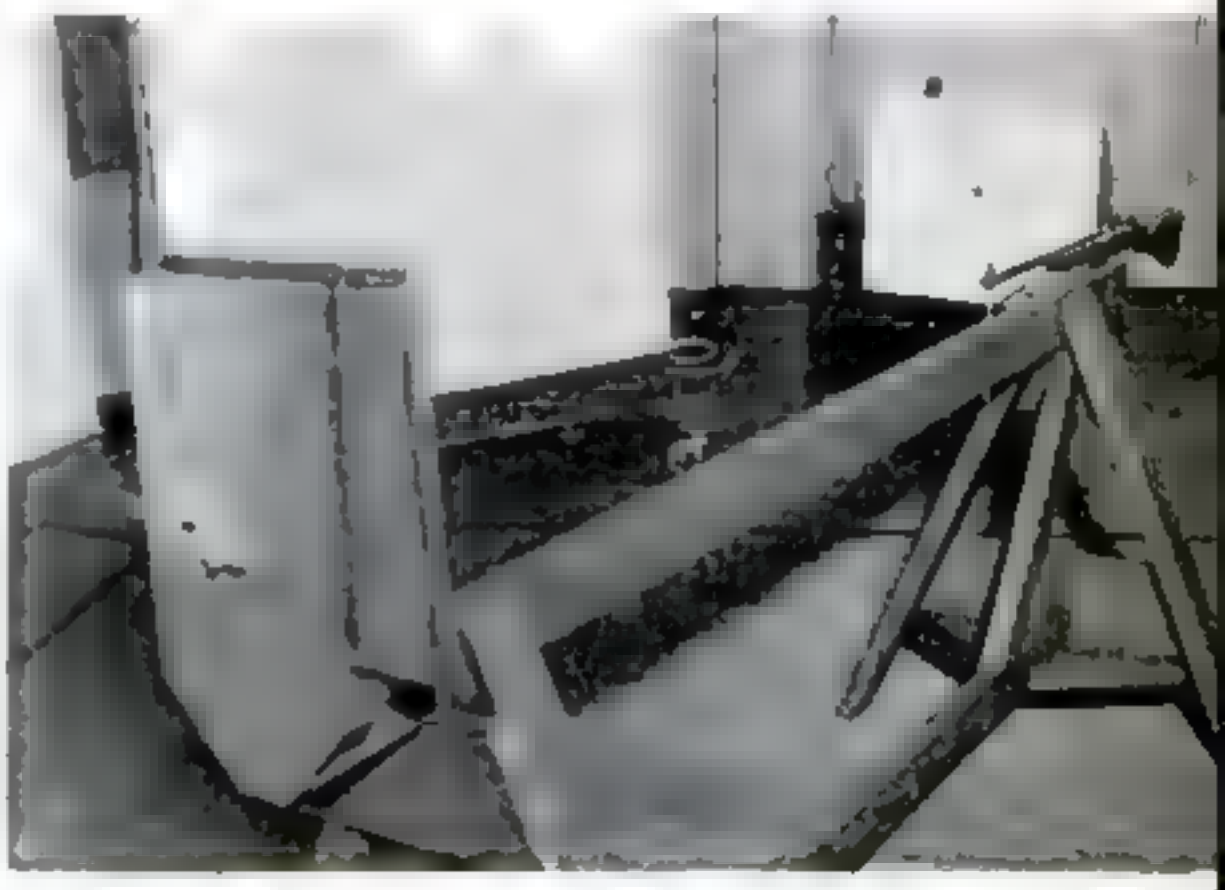
Rifle Sighting Device Uses Mirror

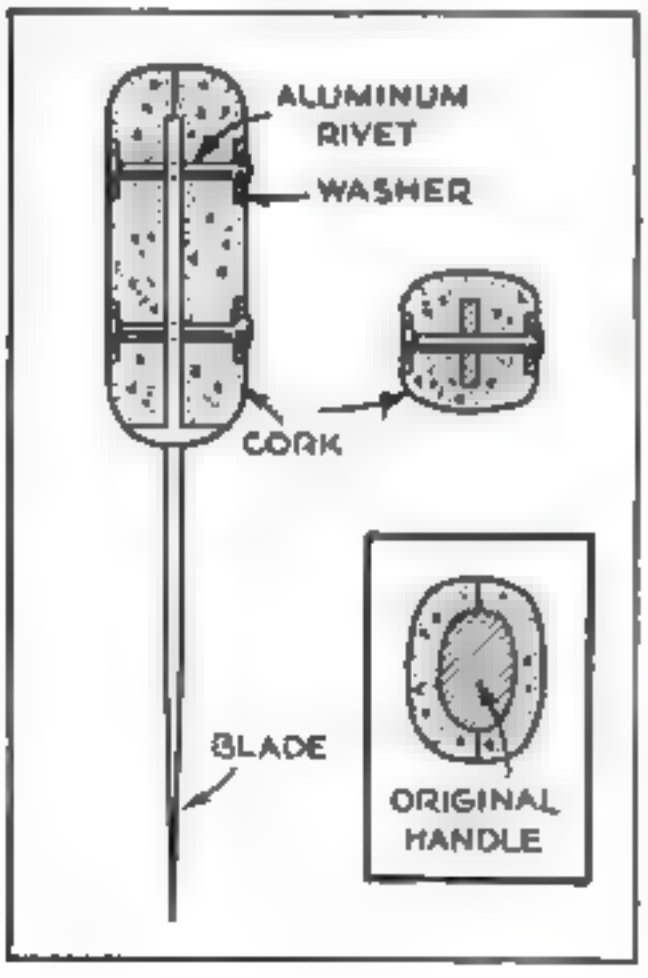
AT THE University of Wisconsin, this sighting and aiming device is used to teach the alignment of gun sights by triangulation. A mirror on a swivel at the far end reflects a target held at the side of the rifle, thus doubling the effective range.

The rifle has an eyepiece in addition to peep and front sights and is mounted solidly at one end of the stand. On a board to its right is a sheet of plain paper facing the marksman. A forked stick fits over the board in such a manner that one leg holds a small target toward the mirror. The other leg has a hole in it directly behind the center of the bull's-eye.

By sighting through the eyepiece and adjusting the leaf, the front rifle sight is centered in the peep sight. The marksman then adjusts the target to obtain a bead on the bull's-eye reflected in the mirror. This he records on the paper with a pencil mark made through the hole in the rear leg. Three trials, before each of which the target is moved out of position for a fresh start, should result in marks close enough together to form a triangle no larger than a dime.

Sighting into the mirror, the marksman adjusts the target to get a bead, which he marks on paper. Below, another view of the device



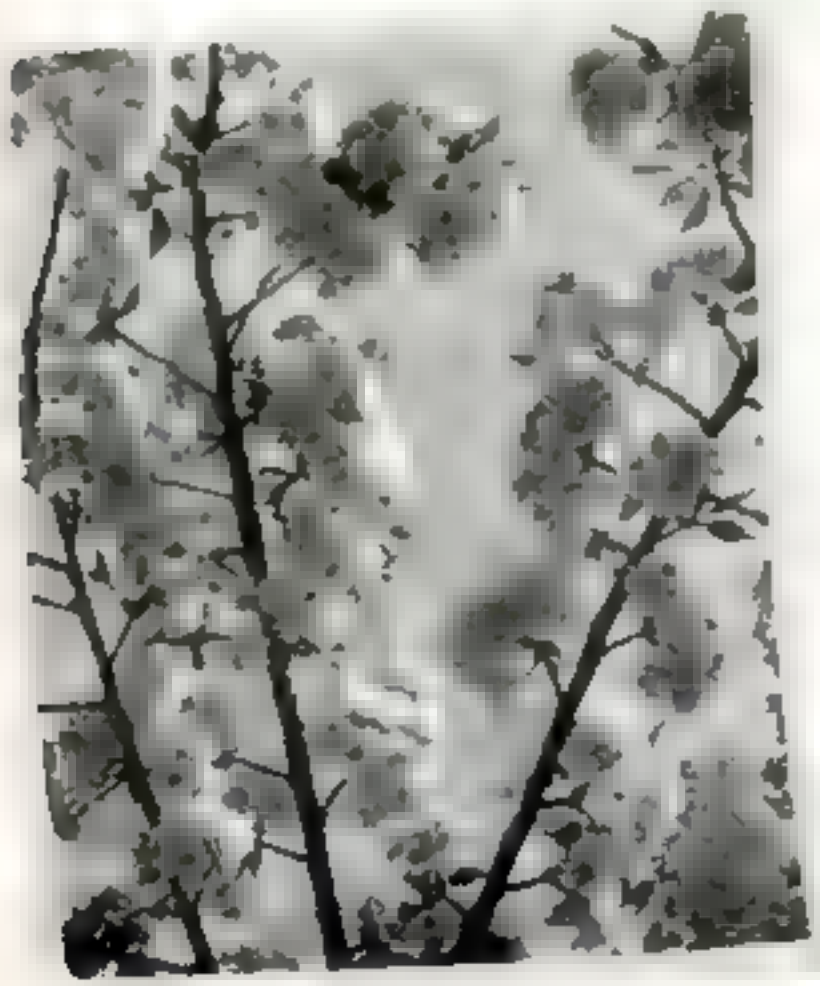


Cork Handle Keeps Fish Knife Afloat

A SIZABLE cork handle on a fish knife not only makes it unsinkable but provides a resilient and comfortable grip. The original handle can be covered with cork if it is not too large and heavy, or the handle can be removed and a cork handle substituted.

Strips cut from scraps of cork flooring blocks or wall board are best to use if either material is available, but cork gaskets can be glued up in layers to serve, or large bottle stoppers can be halved lengthwise and glued end to end. Be sure to use waterproof glue, since the knife will often be soaked in water. For a practical grip, shape the handle slightly oval with a sharp knife and abrasive paper. Attach it to the tang with light rivets and washers, as shown at the left.

The shimmering beauty of these cherry blossoms was greatly enhanced by side lighting. A K2 filter was used to darken the sky. Taken at stop f/16, 1/10 second



Photography in Summertime

By MAC GRAMLICH

THE end of spring heralds the approaching summer season, the time of year ambitious photographers have been anxiously awaiting. Alert picture takers find a wealth of material for summer photos in the great outdoors.

Wartime restrictions, however, forbid many photographic subjects, and the photographer should be very careful to observe all regulations. Keep in mind that such places as power plants, bridges, harbor scenes, and military locations are on the restricted list, and turn your attention elsewhere

Summer pictures can be classified as general photography, and equipment is entirely a matter of taste and convenience. Elaborate and expensive cameras are not needed. With pictorial subjects in which action is not involved, even the least expensive box camera is capable of producing beautiful results. No matter what kind of camera you

A curving road adds much to the composition of this rural scene. Shot on pan film at f/8, 1/100 second, with yellow filter

Caught in the act! This thirsty kitty was snapped with a 4" by 5" Speed Graphic. Panchromatic film, f/8, 1/200 second

use, however, be sure that it is in perfect working condition.

When planning to take several pictures in a nearby locality, study the lighting beforehand. This enables the subjects to be scheduled one after another in accordance with the position of the sun, thus saving valuable time. When taking pictures on a trip, make every shot count. Be discriminating in your choice of picture subjects, and do not shoot everything in sight.

For really brilliant outdoor negatives, sunlight is indispensable. The most favorable times for shooting pictorial scenes are in the early morning and late afternoon when the shadows are most pronounced, although it is true that a few types of pictures are best when taken during the middle of the day. In pictures shot at noonday, when there are no shadows to speak of and all objects are uniformly lighted, the major contrasts are in color variation. Under these conditions, take landscape pictures that have interesting foregrounds. Bring the foreground into sharp focus; let it be the chief point of interest in the picture.

It is often advisable to shoot against the light—a technique called back lighting. An admirable example of this type of lighting is shown in the picture of the ship painters on the following page. Back lighting or side lighting is used to give greater detail and depth to summer pictures. For instance, wagon tracks on a country road will appear without detail of texture if taken with the sun directly overhead, but the same picture will have much more character if it is shot when the sun is at one side. Avoid straight, level shots whenever possible. Better effects are obtained by shooting either from a low angle or from a raised position.

Picture composition can be enhanced by framing the subject with overhanging tree branches or taking the shot through an archway. When open landscape pictures are taken, particular attention should be given to the foreground. A cottage, an old fence, or sometimes a group of animals can be in-

The lens was stopped down sharply for this pattern photo of window shutters. Pan film, ½ second at f/32

Ship painters against the setting sun form an interesting silhouette photograph

cluded to avoid emptiness in the foreground.

On the other hand, don't crowd too many objects into one shot, as they tend to make the picture confusing. Subjects that have no particular relation to a scene are both distracting and annoying.

When landscapes are cropped horizontally, the effect is usually pleasing and relaxing. The choice of cropping, of course, depends on the subject. For example, a picture of very tall trees should be cropped vertically, whereas most pastoral scenes call for horizontal cropping.

It is usually best to take pictures of people, especially children, while they are engaged in some kind of activity. It is sometimes a difficult task to get your subject to concentrate on what he is doing, since the average person tends to become camera-shy and self-conscious. A good trick is to have your subjects rehearse their poses several times, and shoot the pictures while they are rehearsing. In this manner, posed pictures can be made to look very natural.

When taking character studies or close-ups of individuals outdoors, try to get the subject into a position so the sun will strike at about a 45-deg. angle. This will create interesting shadows and give the picture depth and roundness. Use a reflector when photographing people with dark or tanned faces, or those wearing hats that shade their faces. Since the use of reflectors is impossible in candid photography, longer exposures are necessary to get desired detail into shadows.

Subjects for unusual pattern or design photography can be found in abundance in both city and country. Windows, pillars, cobbles, shingles, and fences are a few of the subjects that form interesting patterns.

Strive for a well-balanced composition in your pictures. Do not have too many dark or heavy objects on one side, for such a picture is badly weighted and is therefore unbalanced or "top-heavy." Focusing the picture on a ground glass helps to avoid bad composition.

When judging composition through a ground glass, beware of being misled by the visual values of coloring. In black-and-white photography it is the contrast between light and dark tones of objects which gives quality to the finished picture, and not the color seen on the ground glass.

Color filters are important when shooting outdoor pictures such as flower details, woodland scenes, or cloud formations. The most commonly used filter for general outdoor work is the K2 or yellow filter. Next in use is the light-green filter. Both of these are suitable for panchromatic and orthochromatic films. Red filters are usually used

only to get dramatic sky effects, especially beautiful cloud formations, on panchromatic films. Filters should be used only when color corrections need to be made. For example, a picture of a yellow wheat field with a good sky effect above it should be taken with a yellow filter. This will darken the blue sky, bring out white clouds, and lighten the yellow wheat. To bring out heavy wooded scenes, use a light-green filter. Filter factors should always be taken into consideration, and film manufacturers' guides can be used for this purpose.

Guard against both underexposure and overexposure, for these can ruin a picture even when the lighting is good and the filter used is correct. Save your filters when shooting pictures on a gray or misty day, for under such conditions they are virtually useless. Photographs taken after rainstorms are usually brilliant because the air is free of dust.

For general outdoor photography where speed is not a factor, medium-slow films are preferable. They are less grainy and have greater latitude. Even with a film of medium speed, fast action shots can be made.

The use of a sturdy tripod whenever possible is recommended. A steady support will assure sharp negatives. Another accessory important to good photography is a properly fitted lens shade, but make sure it doesn't shade corners of the negative. A shade prevents unnoticed reflections from striking the lens. Last but not least, use a reliable exposure meter at all times. Light conditions are constantly changing, and the use of a meter is important in order to secure the best results from your photographic efforts.

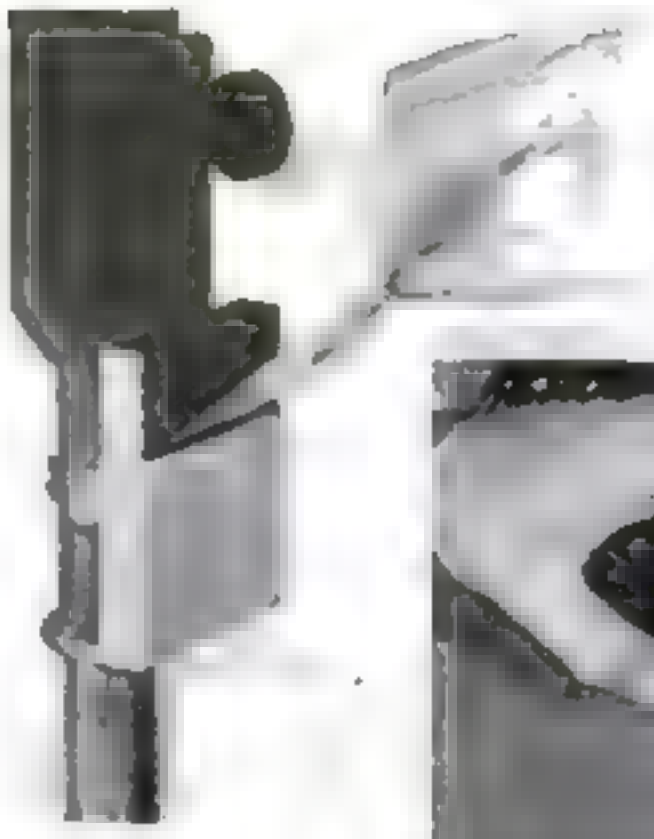
With a camera in good working condition and a few accessories, the amateur photographer ought to be able to spend a busy and successful summer taking worth-while and interesting pictures. Even though you do not go away for a long vacation trip this year, the possibilities of picture material in your own vicinity are unlimited. The alert photographer recognizes good pictures no matter where they may be. Amusement resorts, swimming pools, zoos, city parks, all lend themselves to the photographic art of the wide-awake snapshooter.

Early spring . . . a running brook gracefully framed by a curving archway. Orthochromatic film, f/11, 1/10 second. A tripod was used

This hurtling equestrian was caught in mid-air at a speed of 1/550 second. Shot with a 4" by 5" Speed Graphic, without a filter

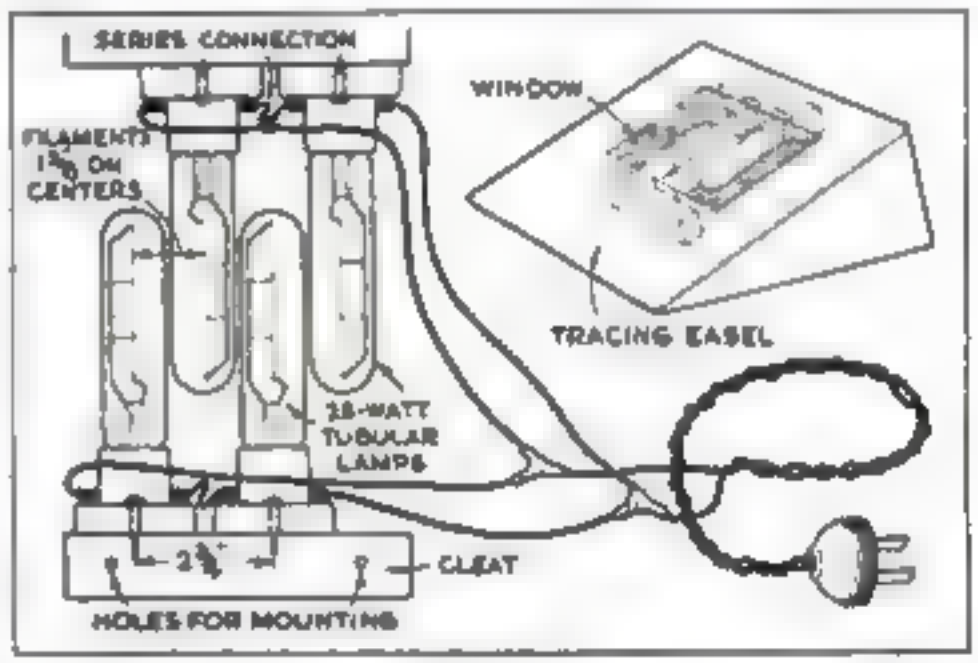
FOR CAMERA USERS

A FILM HOLDER that clamps to the post of the enlarger, or on the sliding sleeve, is shown in the photo at the right. It consists of part of a cut-film box attached to a spring clip fashioned from thin metal. This clip can be held to the back of the box by strips of adhesive tape or by a small bolt. Films placed in the box and attached to the enlarger are easily located, and are kept out of the way of developing and fixing solutions which may otherwise drop on negatives and ruin them. The holder is a convenient time saver.—HARRY RADZINSKY.

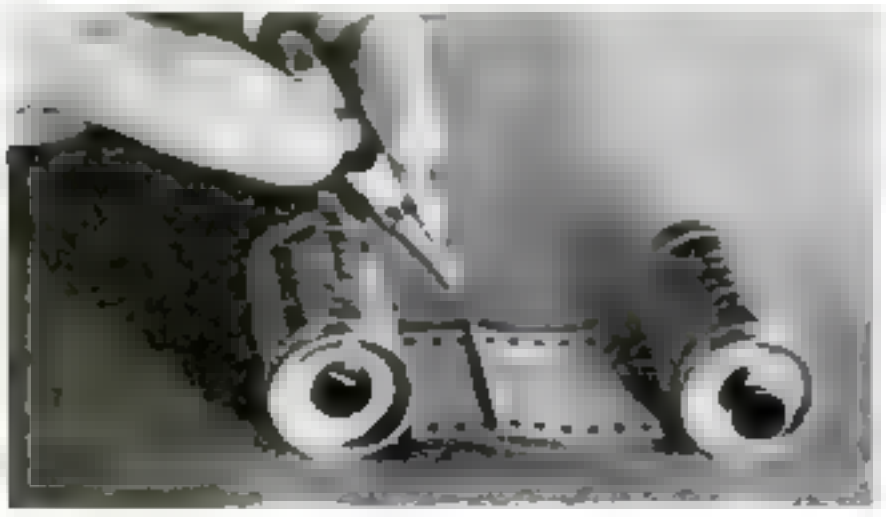


The film holder is shown attached to the enlarger in the photo at the left. Below, a spring clip of thin metal is taped to the back of the film box

UNIFORM LIGHT can be provided beneath the diffusing glass of a spotting easel by installing four 25-watt tubular lamps as shown. In comparison with the single brightly burning lamp usually employed, this unit operates with comparative coolness, for each pair of lamps is wired in series. This permits the lights to be mounted extremely close to the diffusing glass without causing discomfort to the hands. Tests show that the effectiveness of the light for ordinary spotting or tracing is the same whether the lamps are burned at full or at reduced intensity.—J. M.



PHOTOGRAPHIC CHEMICALS in crystal form must usually be crushed in order to speed the mixing process. The frame of a discarded razor is an excellent tool for this purpose. Its curved surface permits it to be pressed down on the crystals with a rocking motion that does an effective crushing job quickly and efficiently. An old razor can usually be found in any home. Be sure that both the razor and crushing slab are clean before using.—WILLIAM SWALLOW.



SHORT LENGTHS OF FILM can be stapled together as in the photo at left, permitting two or more to be developed at one time as a single roll by either the tank or tray method. Sections of film pack can also be stapled and developed as roll film. This method is a great timesaver in the photo lab. Ordinary staples do not seem to be affected by the chemical solutions generally used.—ROBERT SCOTT.

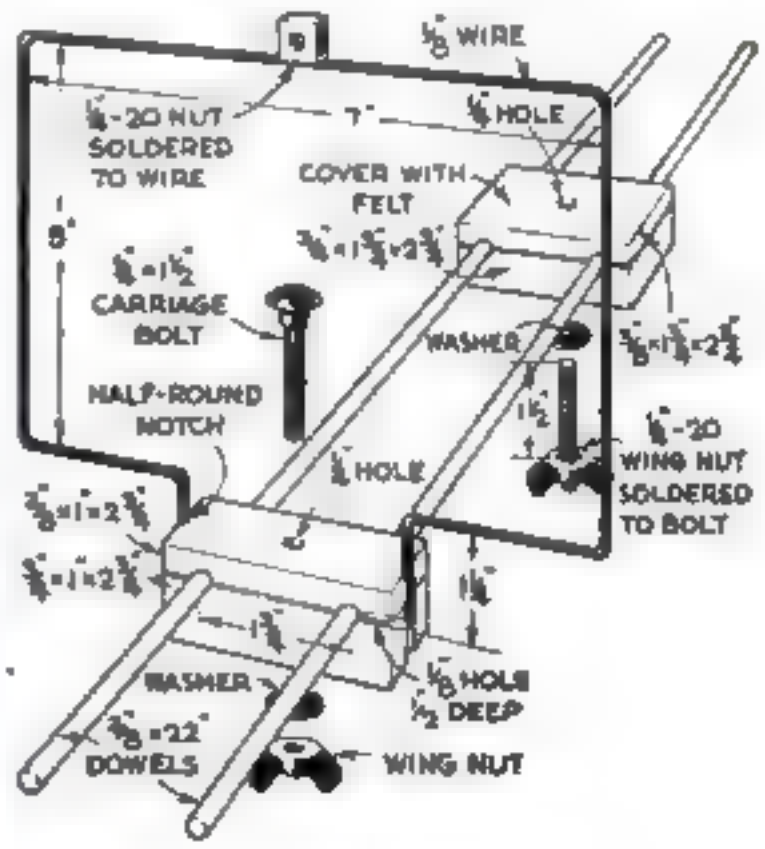
Adjustable Finder Frame Simplifies Shooting Close-Ups

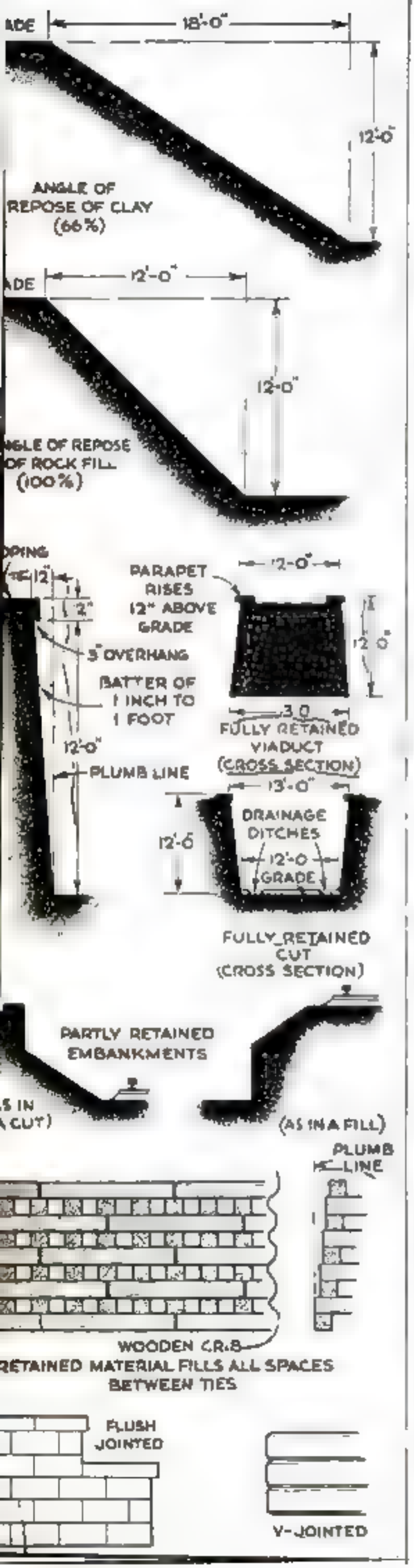
Flowers and other nature subjects are easy to shoot with this focusing finder. Below, a nut soldered to the frame holds it to the camera block when the device isn't in use

TAKING sharp close-ups of small objects such as flowers, insects, and tiny animals in their natural surroundings is simplified by using a finder frame like the one shown at the left. It is designed for use with double-extension cameras or single-extension cameras and supplementary lenses. By stretching rubber bands on the wire frame and setting the two sliding blocks as the focus may require, any field from negative size up to 5" by 7" can be framed off.

Cut blocks 1" by 2¾" and 1¾" by 2¾" from 1¼" stock. Bore two ⅜" holes through each, 1⅜" apart and 7/16" from one face; then saw the blocks apart on the center line of the holes. The blocks are locked in place with wing nuts and ¼"–20 bolts on two straight ⅜" dowels. The wire frame is held upright in two notches filed in each end of the front block. A nut soldered to the upper part of the frame secures it in the folded position to the screw in the camera block when the device is not in use.

Adjust the camera to bring the desired field of view inside the limits of the ground glass, and focus accordingly. Any subject in the plane of the frame will then be sharp on the film. With cameras having no ground glass, tape a piece of tracing paper over the film rollers and focus visually on any convenient subject to determine by experiment the lens settings for various distances and the corresponding field areas.—FRANK HEGEMEYER.





Model-Railway

By DAVID MARSHALL

YOUR model railway is either made or marred by the accuracy with which the grade, at every point of line, balances cut against fill. The grade is the vertical profile of the track from terminal to terminal—a series of ups and downs and level stretches that follows the major contour yet also smooths out the minor inequalities of the land.

For us who are model railroaders, the grade is the batten or flooring on which we nail down our track, and our problem is to create the hills and valleys which will give us a well-balanced result. This necessity will in large part determine the character of the terrain that you will have to build around your model pike. Almost inevitably it will oblige you to construct retaining walls. These are extremely interesting to work with, yet you have no authority for building them unless you are by necessity driven to it.

ANGLE OF REPOSE. We can approach the subject of retaining walls precisely as if we were civil engineers at work on a grown-up railway. That is, we particularly notice the angle at which the earth is excavated to form a cut and the angle at which the sides of the embankment slope outward. This angle depends upon the character of the material excavated and dumped, and that material can range all the way from sand to granite. You can build an embankment of sand, but the sides of the embankment cannot be steep because sand settles at a low angle, or has a low angle of repose.

The model railway must be compact, and the railroader ought to represent compact substances such as clay and rock, for these are the two that make the

A model main-liner roars out of a realistic tunnel amid skillfully built hills. Note the flagged embankment beside the tracks

Retaining Walls

steepest banks. With due allowance for a margin of safety, heavy clay has an angle of repose of 66 percent, and broken rock rests well at a slope of 100 percent. In other words, a clay embankment should not slope upward at a rate of more than 8" to the foot, which is 30 deg., while a rock-fill job can slope 12" to the foot, which is a 45-deg. angle from the horizontal.

Use the rock fill among hard-rock hills, the clay embankment in rolling country.

SPLIT SLOPES. Cuts and fills need a great deal of lateral space. A clay embankment 4" high adds 12" to the width of your right-of-way, and a clay cut 4" deep is 12" wider at the top than at the bottom. You can't change these things, which are among the inflexible items of model railroading. However, when you lack space for these slopes, you have a right to use retaining walls, which may fully retain the embankments, as in the drawings of the viaduct and cut on the facing page, or you may use part wall and part slope with either above the other. In the sketches, this combination is shown as cut and fill embankments. In practice, of course, the two types are interchangeable.

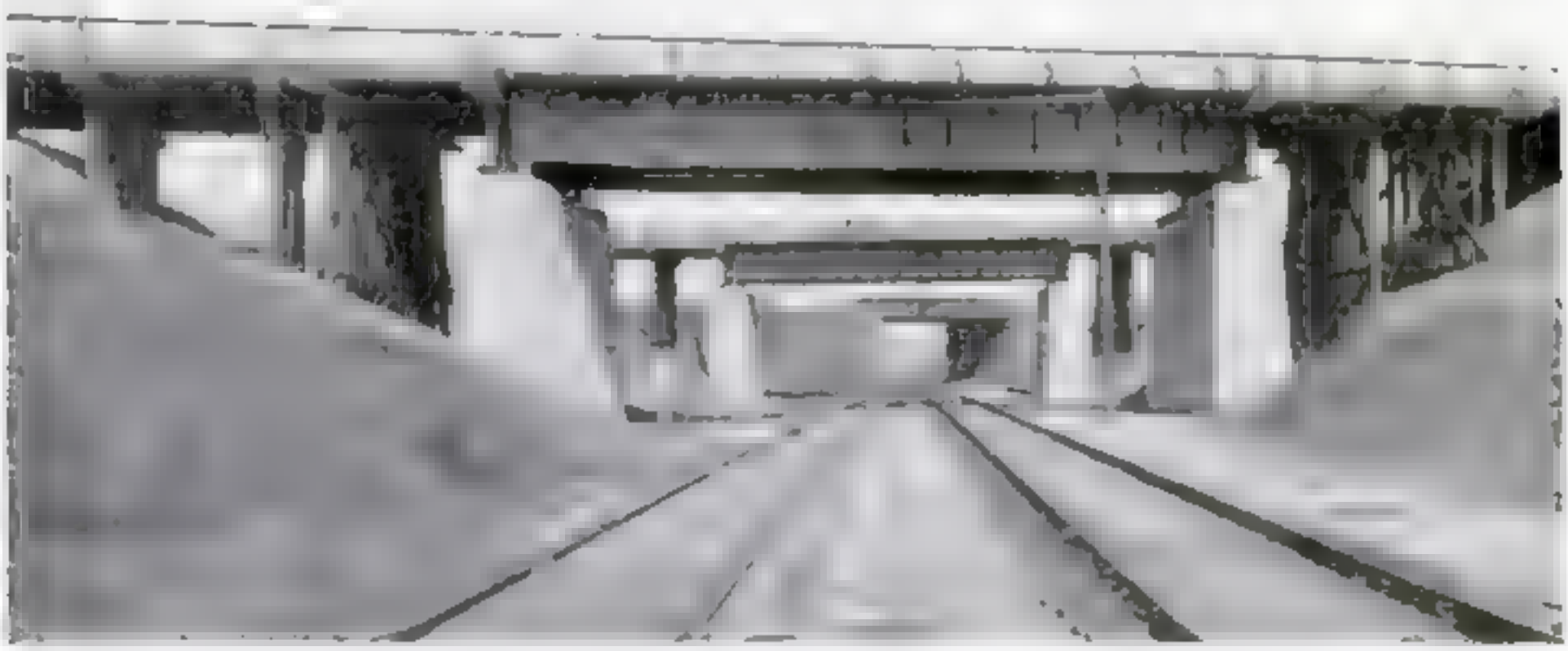
A final word about embankments: a rock-fill job is always covered over with a layer of good soil. Then the embankments are planted with grass or shrubs so that the roots of these will form a binding element and prevent erosion. Thus only the greater angle of repose, plus the protruding shoulders of rock fragments, distinguishes a rock fill from a clay embankment.

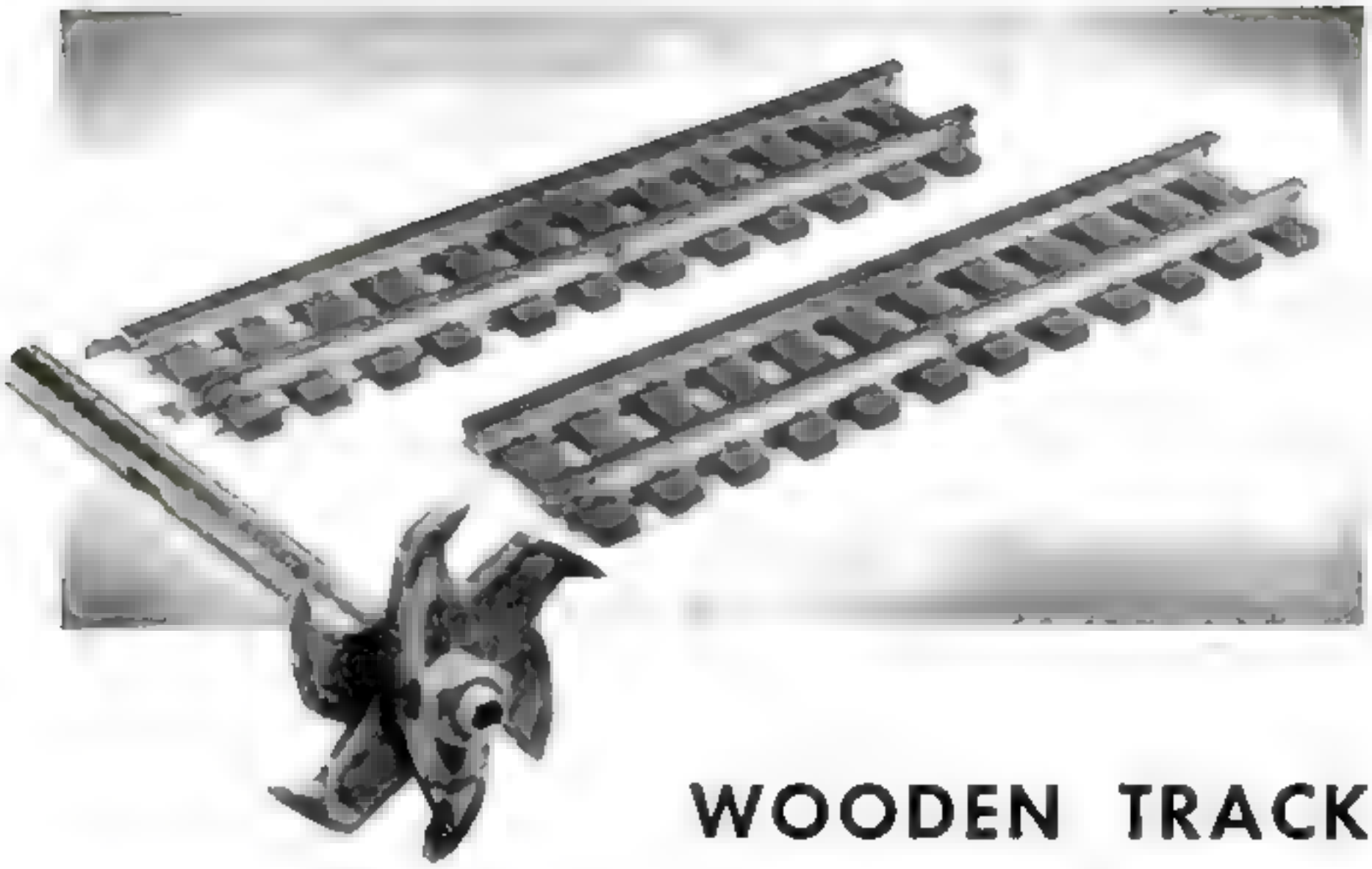
MASONRY AND CONCRETE. Most of the retaining walls built in recent years are of concrete, though the older and more interesting types of masonry walls are still fairly common. Our retaining walls may be sturdily built of wood and painted on all sides to prevent warping. As a rule, retaining walls, whether of concrete, stone, or brick, are built with a batter so as to lean back several inches out of plumb.

The coping at the top usually overhangs the facade by 3". In some instances, however, the overhang is 4", or sometimes the coping is flush with the facade. In almost every instance the coping is 12" thick, which means you can make it—if you're an O-gauge railroader—out of wooden ties left over when all your track is laid. On the other hand, if the embankment is not more than 8' or so in scale height, it can be retained by cribbing. And here again you have use for excess ties.

Masonry walls, to a large extent, are built of rectangular stone of uniform size. The size is not standard, of course, but the blocks commonly used present a face 15" high by 48" long. Flush joints and V-joints are equally common, the ramps are stepped, and ends are formed simply by squaring off the stones.

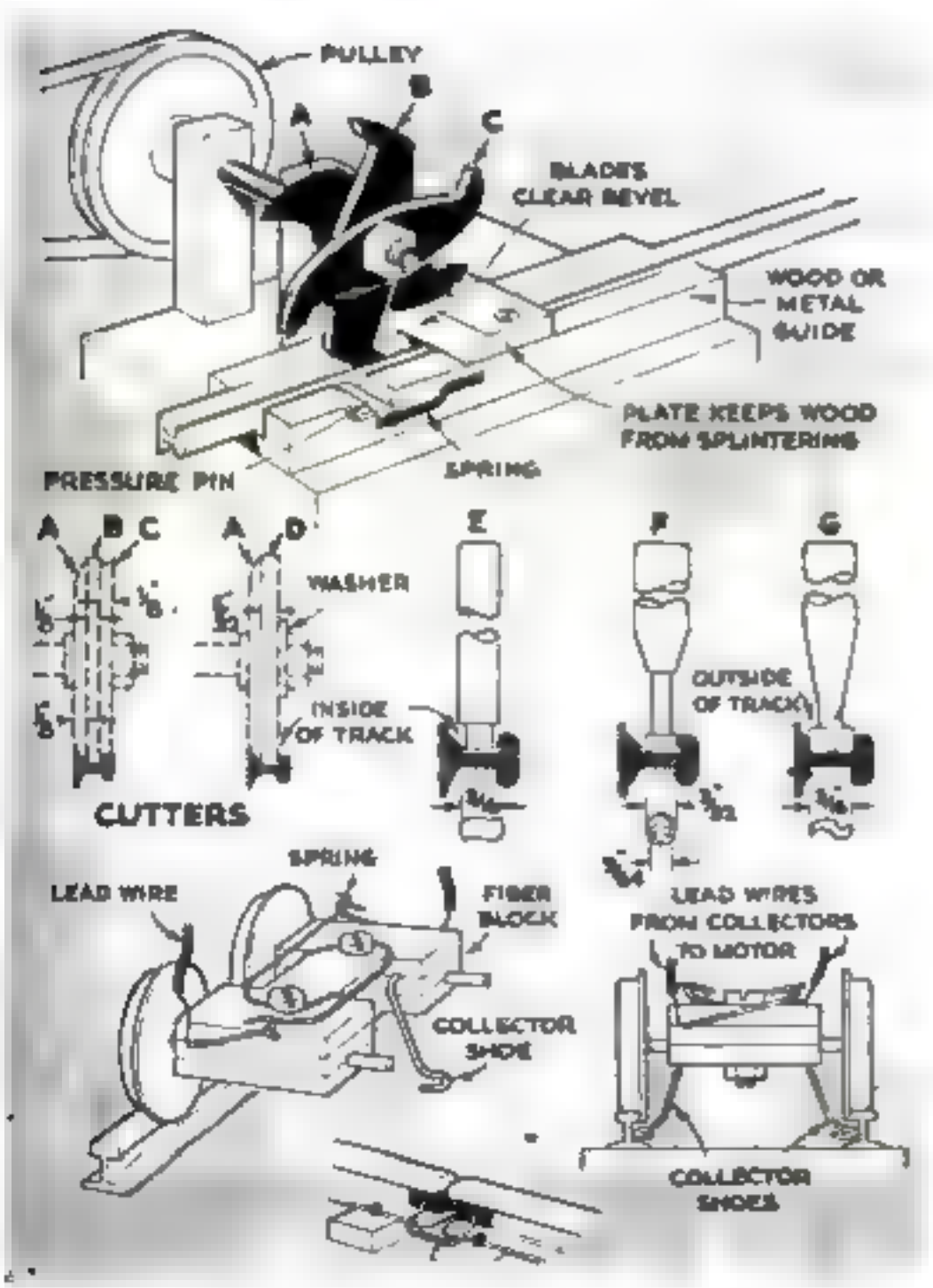
Cuts and fills must have correct degree of slope depending upon the type of soil represented
Below are typical grass-covered embankments bordering the tracks in a cut on a real railroad





WOODEN TRACK

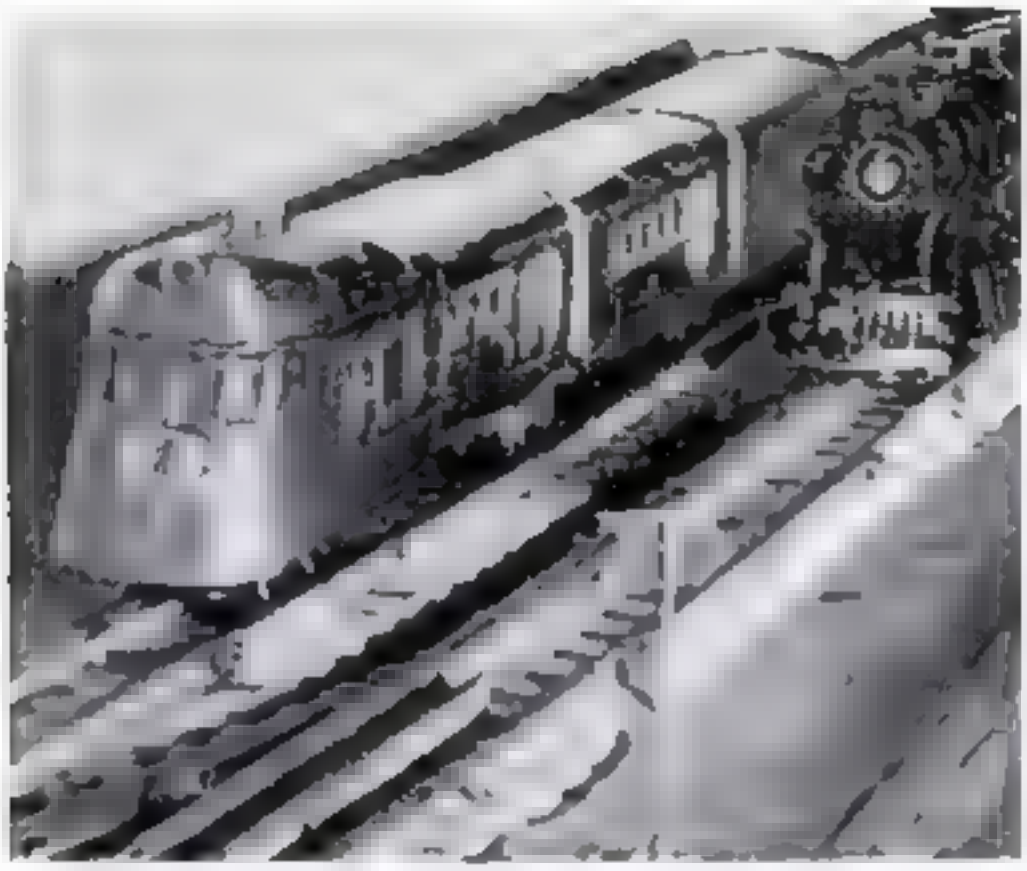
for Two-Rail Systems



MODEL railroaders faced with a possible shortage of metal tracks for extending their systems may like to try making their own tracks out of wood. With 85′ of wooden trackage, including switches, in operation for more than two years on my O-gauge system, I find that wood has even some advantages over metal. Operation can be made almost noiseless, depending on the material on which the tracks are mounted. The cost is low—materials for 85′ of track might be kept to little more than $3. Furthermore, wooden tracks make two-rail operation possible without any need for insulating wheels.

Birch has proved satisfactory for the straight tracks, but pine serves better for curves, especially for those of small radius, since it is easier to bend. The tracks are made to scale, except for height, which is a little greater (⅝") but looks "in proportion." Four special cutters ground from steel to the shapes shown in the drawings, as well as a spindle, two routers, and a countersink, are needed.

Cutters *A*, *B*, and *C* are



mounted on the spindle as in the drawings and used either in the drill press or in the special rig shown. The stock is first squared to size, then pushed up to the cutters through a guide that holds it in position.

When one side is finished, the piece is turned over and the other side is shaped. A thin strip may be used to shim up the rail for this second cut. Where stock runs undersize, it will be necessary to set a pressure pin in the jig to hold the work against the cutters.

The shaped stock is next cut off to size—12" lengths are used in my system—and the web on the inside is flattened with cutter *D*. This is best accomplished by substituting cutter *D* for *B* and a washer for *C*. Cutter *A* is left on the spindle as a spacer.

Router *E* is then chucked in the drill press, and the flange and tread on the inside are undercut for receiving a metal conductor strip. Tapered holes are drilled with countersink *F* for fishplate bolts, and the rail is turned over for routing spaces at the ends to receive fishplates. This is done with router *G*. Two bolts are used in each fishplate instead of the customary four.

Metal strips cut from tin cans run along the inside of the rails to deliver electricity to the locomotives. One strip is inserted at each end of a rail, and the two are joined at the center with solder applied through a hole in the rail at the halfway mark. This is easier than trying to solder from the inside. A simpler method of inserting the conductor strips is to run one the whole way through each rail. In this case, soldered wires join the ends, and fishplates and bolts are not needed.

In cutting the strips with tin snips, you will find that the metal curls and will have a decided curve when uncurled. The strips can be straightened by tapping the inside curve gently with a ball-peen hammer to expand the metal there. Be sure to lay the pieces on a steel plate, for otherwise tapping will dent them badly. A punch ground to an angle corresponding to the bolts will make countersunk holes in the strips if used over a countersunk hole in a steel plate.

Collector shoes used in third-rail systems are wedged out of the way, and a special fiber block carrying two contact shoes is mounted on the axles of each tender truck. The blocks should be free to slide sideways on the axles.—JOHN S. MEDCALF.

WIRE FOR HEATING ELEMENTS [ELECTRICAL]

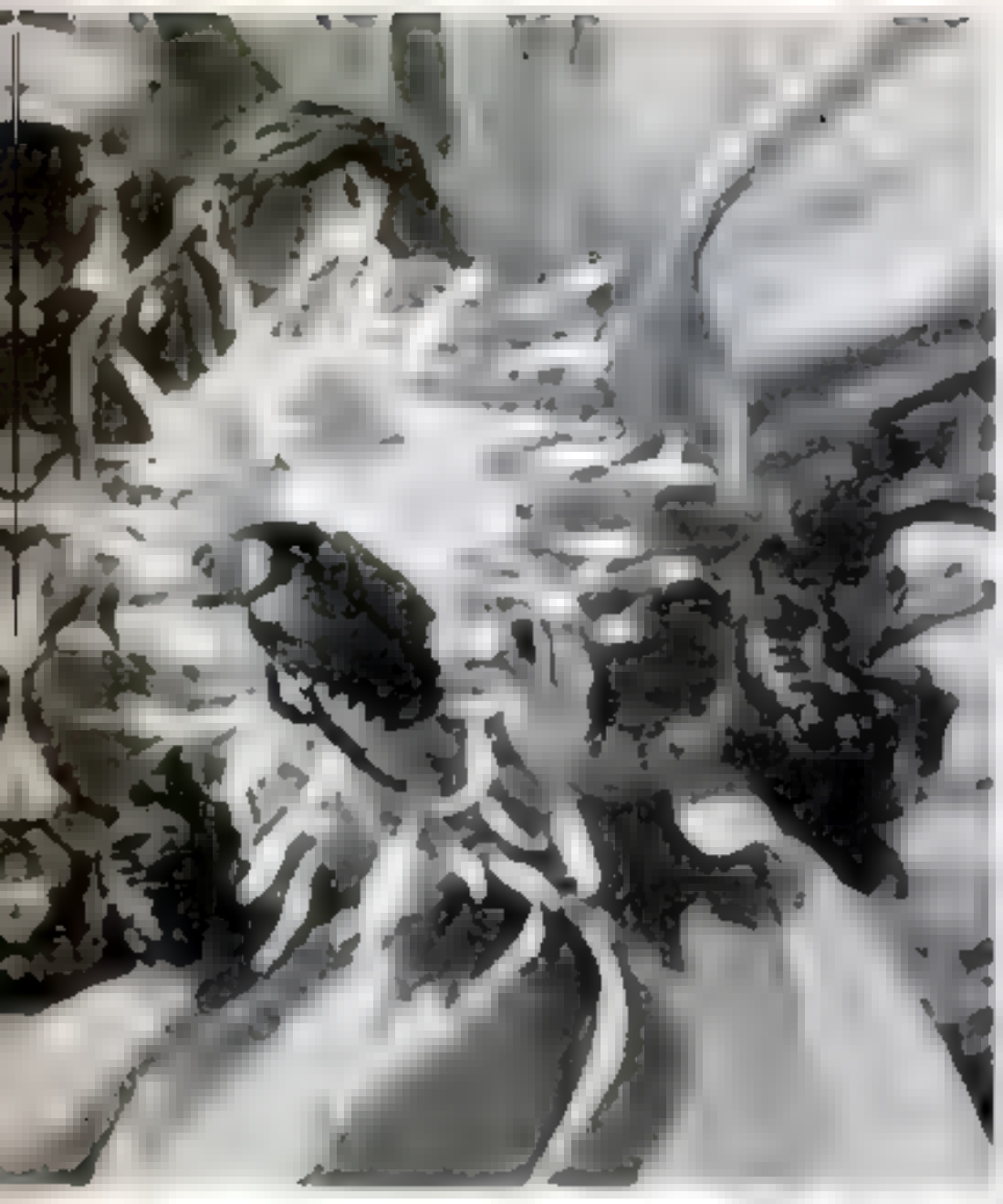
The following table gives the length and size of nickel-chromium resistance wire of about an 80-20 alloy for repairing heating units or designing new ones to operate on 110 volts A.C. or D.C.

Watts	250	300	350	400	450	500	550	600	650	700	750	800	850	900	1000
Amps	2.27	2.73	3.18	3.64	4.09	4.55	5.00	5.45	5.91	6.36	6.82	7.27	7.73	8.18	9.10
Ohms at 75 deg. F	45.3	37.7	32.3	28.2	25.1	22.6	20.6	18.9	17.4	16.2	15.0	14.1	13.3	12.5	11.3
B. & S. Ga.	Length in Feet of Straight Wire														
16															45.2
17													41.6	39.0	35.2
18										39.9	37.0	34.7	32.8	30.8	27.8
19							41.0	37.7	34.7	32.3	29.9	28.1	26.5	24.9	22.5
20					19.6	15.6	32.5	29.8	27.4	25.5	23.6	22.2	20.9	19.7	17.8
21					31.3	25.2	25.7	23.6	21.7	20.2	18.7	17.8	16.6	15.6	
22				27.7	24.7	22.2	20.3	18.6	17.1	15.9	14.7	13.9			
23			25.4	22.1	19.7	17.7	16.2	14.8	13.7						
24	28.1	23.4	20.1	17.5	15.6	14.0									
25	22.3	18.6	15.9	13.9											
26	17.6	14.7	12.6	11.0											
27	14.0	11.7	10.0												
28	11.0	9.20													

For each volt above 110 (up to 120) increase wire length 1.8 percent. For each volt below 110 (down to 100) decrease wire length 1.9 percent.

POPULAR SCIENCE MONTHLY SHOP DATA

Blitzing

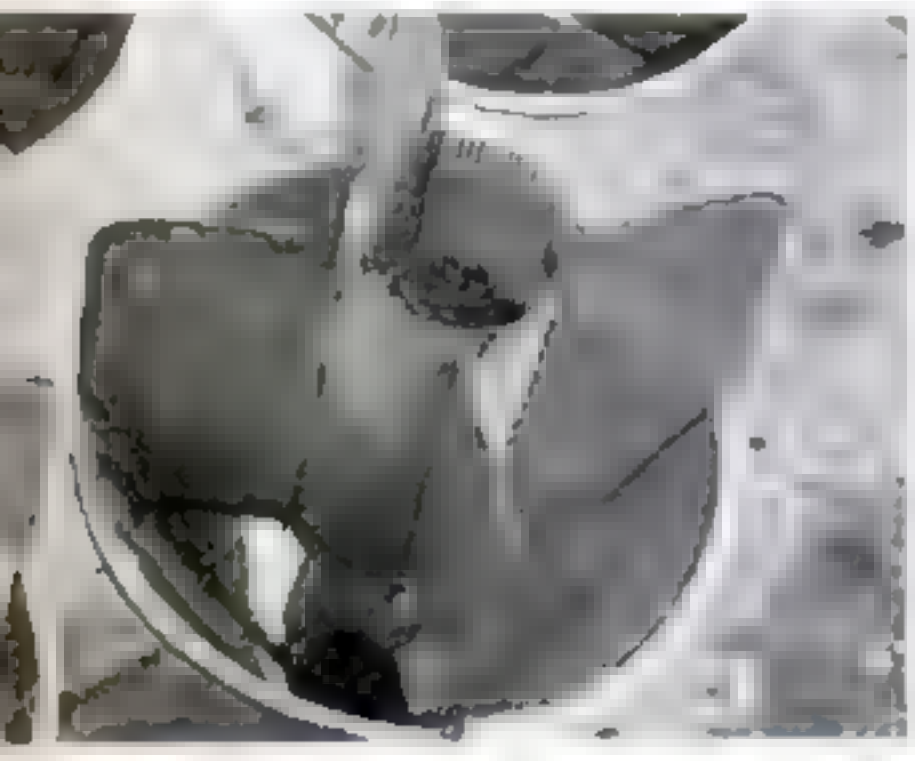


White dahlias are a late-season food for this most destructive of all garden pests. The earlier beetles are trapped, the less time they have in which to work damage

Japanese beetles attack leaves of hazel and linden trees about mid-June, leaving only veins. Set your traps early in the season in order to protect your garden

Seven arge commercial beetle traps ke the one below can be set n the l d of a b g ash can or similar receptacle to catch the insects who eso e

An extra strong attraction for these garden enem es consists of several traps set together and trimmed with part y eaten flowers dipped nto bait solut on



the Japanese Beetle

Ingenious Multiple Traps Can Be Made of Standard Units to Catch This Enemy of Our Gardens by the Bushel

SOAKING the Japs can be done profitably in more ways than one. Those who cannot go to the front can take a crack with bonds and war work and, in addition, can get some of the feel of the thing by taking an extra wallop at the Japanese beetle. There are many traps sold in infested areas for ridding trees, Victory gardens, and flower beds of the destructive Nipponese visitor, but L. J. Mulier, of Westbury, N. Y., has devised a way of combining several commercial ones to catch the pest in a big way.

About seven of the biggest of the traps can be set up in holes punched in the top of a large ash can. This provides space for seven times the usual amount of the aromatic bait that attracts the beetles. The ash can, partially filled with kerosene or a similar insecticide, will be a death receptacle for bushels of the insects at a time.

Another good device may be made with an extra large funnel to which is soldered a bait holder like those shown in the photographs. The funnel may be inserted in a hole in the top of a large can or through wire netting soldered to the underside of an old dishpan from which most of the bottom has been cut. This dishpan can be set over a washtub or garbage pail to provide a top through which trapped beetles cannot crawl

Also an effective killer is a mixture of 1 pt. molasses and 4 teaspoonfuls Paris green in 1 gal. water. *This is extremely poisonous* and should be kept well out of the reach of children and pets. A large pan of this mixture may be set up high in the garden and baited with flowers already partially destroyed by beetles. Such flowers may also be used on top of bait holders in the funnel traps. They will attract still more pests if soaked for a short while in some of the bait mixed with water.

Japanese beetles feed on almost anything in the garden, but they usually appear first on grape vines, raspberry bushes, roses, and linden and hazelnut trees about the middle of June. Later they choose white dahlias and marigolds as their favorite flowers. Repellents used freely on growing things will help to save them from the voracious appetite of the insects. One recommended repellent is arsenate of lead and lime for trees, while a mixture of 1 pt. liquid soap, 4 teaspoonfuls garden lime, and 2 teaspoonfuls arsenate of lead to 3 gals. water is excellent for flowers and vines. The spray should be repeated after each rain if attacks continue.

Arsenate of lead powder applied to a lawn in the fall kills many beetle grubs before they develop and keeps them from destroying grass roots.

In traps covered with open wire mesh, as this one is, some gardeners use only water claiming that the smell of kerosene warns beetles away

To make traps blend with flowers and foliage and so render them less noticeable, they may be daubed with paint. This giant trap is mounted on a garbage pail

This huge capacitor is part of a 10,000-kilovolt impulse generator used for throwing a spark of high-voltage, man-made lightning across a 30' gap

charged negatively, and will drive out free electrons from the outer surface, since like charges repel. As the outer surface is connected to the positive terminal of the generator, the repelled electrons pass through the conducting wire to the positive terminal of the power source, which is deficient in electrons.

When the condenser is disconnected from the generator, the inner surface has an excess of electrons and the outer a deficiency, showing that electricity has been stored. This can be proved by shorting the two foil surfaces with a wire. If this wire is held by an insulated handle against one foil surface and near the other, a surge of electrons in the form of a spark will jump across the gap. The condenser is the only electrical device that can actually store electricity directly.

The measure of the ability of a condenser to store electrons is called its capacitance, and the unit measurement of capacitance is the farad. A capacitance of one farad means that a condenser is charged to an electrical pressure of one volt by a current of one ampere flowing for one second. This is such a huge unit that for practical purposes small

How Condensers Put the

FIRST STEPS IN ELECTRONICS

By CHARLES I. HELLMAN

THE giant air condenser used to set the frequency of a 50-kilowatt transmitter the midget condenser in a portable military two-way radio, the capacitors in which bolts of artificial lightning are stored, all make use of the principle of the Leyden jar which was discovered almost 200 years ago by Prof. Pieter van Musschenbroek of the University of Leyden.

A Leyden jar is essentially a glass jar coated with tin foil inside and out for part of its height. The foil surfaces are entirely separated by the glass, which acts as an insulator, or dielectric, as it is called. The jar is charged by connecting the two foil surfaces to any source of high-voltage D.C. Excess electrons are stored on the negative terminal of the generator and overflow through a conducting wire to the inner tinfoil surface. This surface is therefore

subdivisions are used. A typical capacitor used in the power supply of a receiver may have a 16-microfarad capacitance. The microfarad is a millionth of a farad. Exceedingly small capacitance is sometimes stated in millionths of a millionth of a farad, or in micromicrofarads.

The capacitance of a condenser depends upon the area of the plates, the distance between them, and the material used as the dielectric. The Leyden jar, despite its bulk, has very little capacitance because the metal foil area is small and the glass dielectric rather thick. Benjamin Franklin devised the flat type in Fig. 1, page HW 236, which may be as large as convenient, or can be rolled up if necessary. Modern capacitors are usually of this type, although glass has been largely replaced by other dielectrics.

Most common of the dielectrics used today are mica, paper, and air. The air condenser generally has one set of movable plates made of aluminum or brass to permit variations in capacitance. Its movable plates are called the rotor and its fixed plates the

stator. When the rotor is turned so that its plates lie entirely within those of the stator, the maximum capacitance results. As the rotor is turned out, the effective area of the condenser is reduced, and the capacitance is decreased.

Since the capacitance of an air condenser is easily varied, it is used for tuning the electrical circuits of a transmitter or receiver. In most receivers, several condensers must be tuned simultaneously. This is accomplished by mounting the rotors of the condensers on one shaft, a process called "ganging."

Since the spacing between the plates of receiving condensers is small, any conducting particles falling between them may short-circuit the condenser and destroy its usefulness. Variable condensers should occasionally be dusted by blowing air between the plates, and they should be handled with care.

Paper has a fairly high dielectric strength, hence very thin sheets can be used to insulate the foil surfaces, which results in a very high capacitance in a small space. Paper condensers are always constructed to have fixed capacitances.

The conducting plates of these condensers are of thin tin or aluminum foil, and the dielectric is made of several layers of thin paper rather than of one layer of heavy paper. Thus, even if there are imperfections, these are not likely to occur at exactly the same spot in all the layers. Long strips of foil and paper are rolled into a compact form (Fig. 2) and sealed into a container of cardboard or metal encased in wax or oil. The paper tubular condensers of a radio are an example.

Paper condensers are made in capacities from

Electron to Work

0.0001 to 8 mfd. Since paper suffers a considerable loss as a dielectric at high frequencies, this type is not used where the highest efficiency is required.

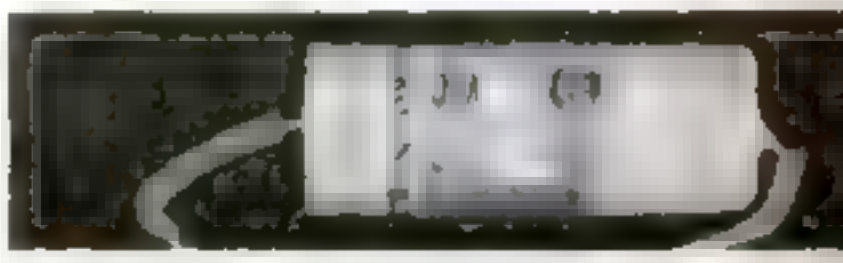
Mica is one of the best materials for use as a dielectric in a fixed condenser. It has a high dielectric constant; that is, it produces a capacitance five times that of an air condenser of similar construction, and its strength against breakdown is satisfactory for a great many applications. A typical mica condenser is shown in an accompanying photograph. Since mica condensers are comparatively expensive, they are used only when small capacitances at high efficiency or high-voltage ratings are needed, as for example in the radio-frequency sections of transmitters and receivers. In D.C. and low-frequency work, paper condensers meet ordinary requirements.

Today, paper condensers of capacitance above 2 mfd. have largely been supplanted by the electrolytic condenser, which has many times the capacitance of a paper condenser of the same volume and is less expensive to make, although its life is somewhat shorter.

The electrolytic condenser derives its name from the fact that the dielectric is a thin film of corroded

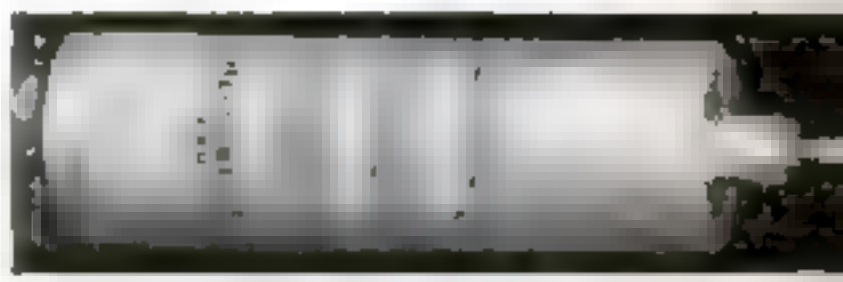
BLOCK OF SEVERAL CONDENSERS

DRY ELECTROLYTIC CONDENSER



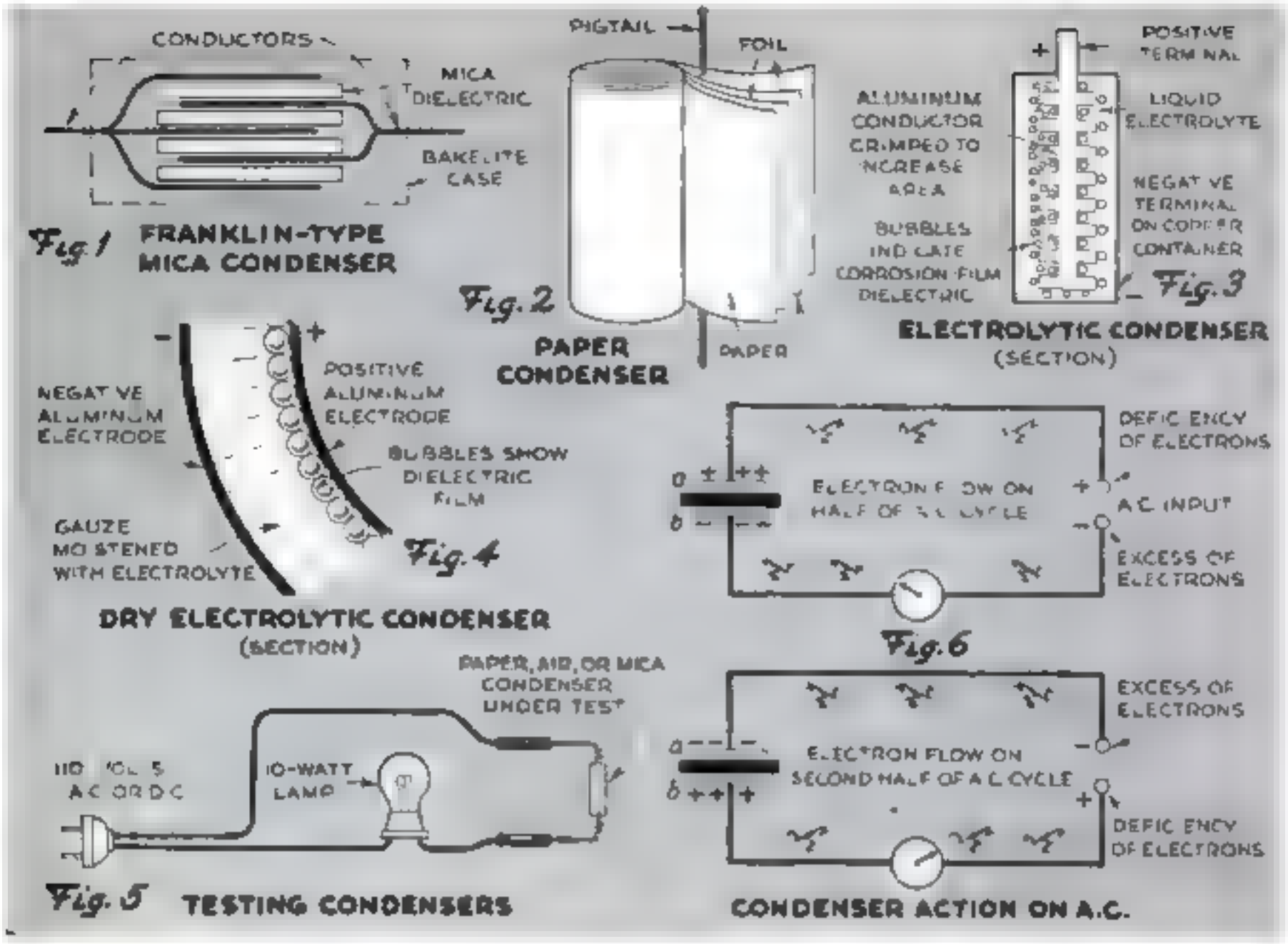
PAPER TUBULAR CONDENSER

MICA CONDENSER



ELECTROLYTIC CONDENSER IN CAN

BY-PASS CONDENSER



aluminum formed by electrolytic action. The first electrolytic condensers were of the wet type shown in Fig. 3, but they have been largely replaced by the dry electrolytic condenser, the construction of which is shown in Fig. 4. The electrolyte is inserted in the form of a saturated gauze.

These condensers have polarity and must be connected as marked on the case. Electrolytic condensers pass some current, even when connected to a D.C. source, and are used where large capacitances are needed and where some losses can be tolerated, as in filtering the output of the rectifier in power supplies.

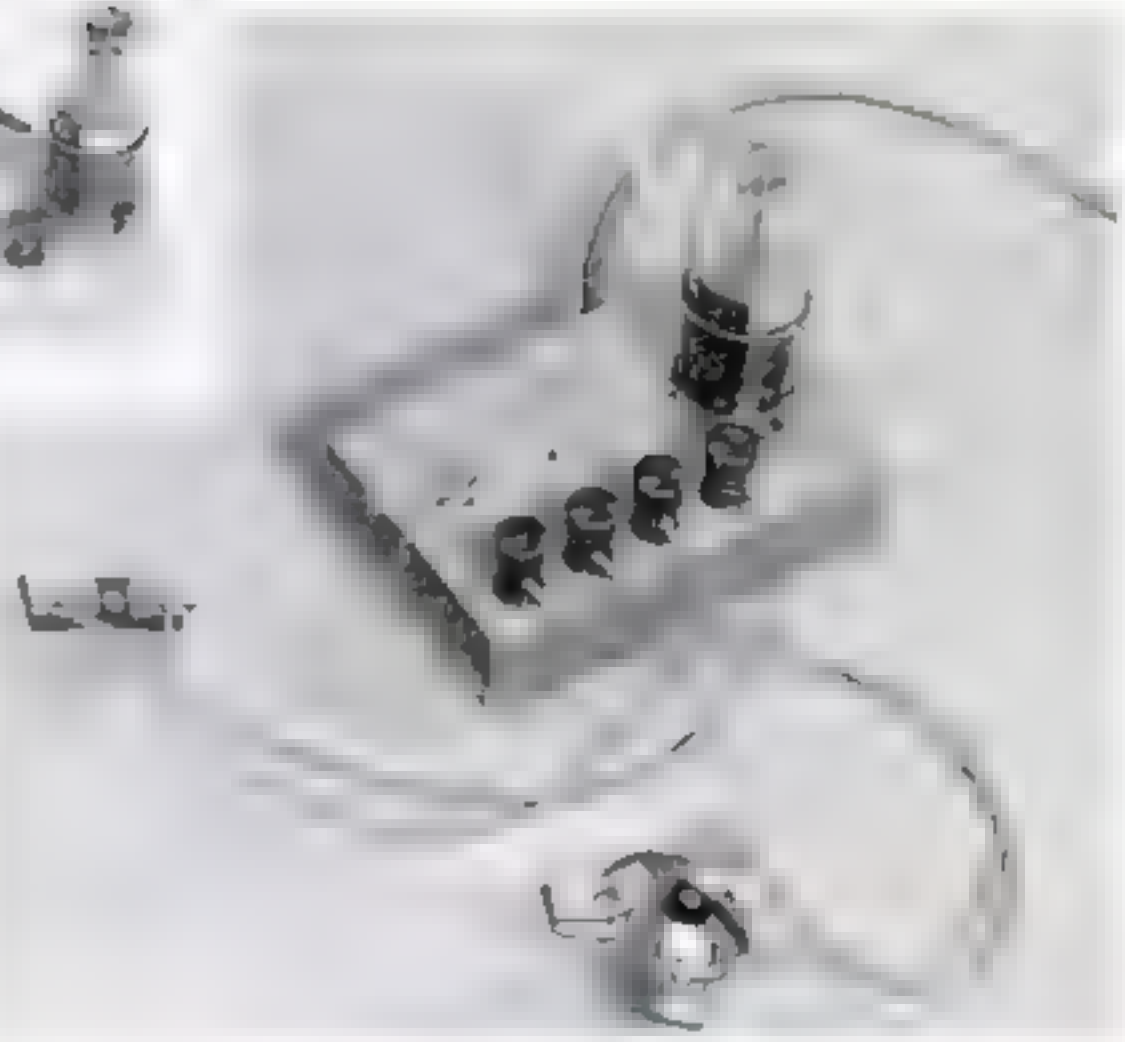
With parts from a disassembled radio set, and odds and ends of electrical equipment, you will probably find all the materials you need to conduct several interesting experiments that will help explain condensers.

Paper, air, and mica condensers may be tested by using the simple circuit shown in Fig. 5. Condensers of this type, of a capacitance of 0.1 mfd. or less, are in good condition if they do not pass enough current to light the 10-watt lamp in the circuit. An electrolytic condenser is tested by connecting it for an instant across D.C. of not more than 300 volts. If it is in good condition, it should produce an appreciable spark when removed from the power supply and shorted.

The following experiment will prove that the higher its capacitance, the more electricity a condenser will store at a given charging voltage. Charge a 1-mfd. paper condenser across any D.C. source (90 volts of a "B" battery or the output of a power supply). Now discharge the condenser across a 10-watt, 120-volt tungsten lamp. It will glow momentarily, proving that the condenser has stored electricity. If you repeat this experiment using a 4-mfd. condenser, the lamp will glow much more brightly.

A good condenser, with the exception of the electrolytic type, will not pass D.C., but will permit an appreciable amount of A.C. to pass through it, as shown in Fig. 6. Using the same apparatus as in Fig. 5, connect a 4-mfd. condenser across a test circuit and apply 110-volt D.C., then 110-volt A.C. Since the dielectric of a condenser is an excellent insulator, a steady voltage cannot pass through it. However, when the condenser is connected to A.C., it is charged on half the cycle of the alternating voltage and discharged on the other half, as shown in the drawing. This charging and discharging results in a current through the conductors although at no time does the current pass through the dielectric. This property of a condenser—the blocking of D.C. while A.C. is permitted to pass—is of considerable importance in electronic circuits, where it is frequently necessary to separate A.C. and D.C. or block the latter. Condensers used thus are called blocking or by-pass types.

Charging a "B" battery from house current, left. "A" batteries are connected to the other two posts on the charger for similar rejuvenation. Only one battery should be recharged at a time

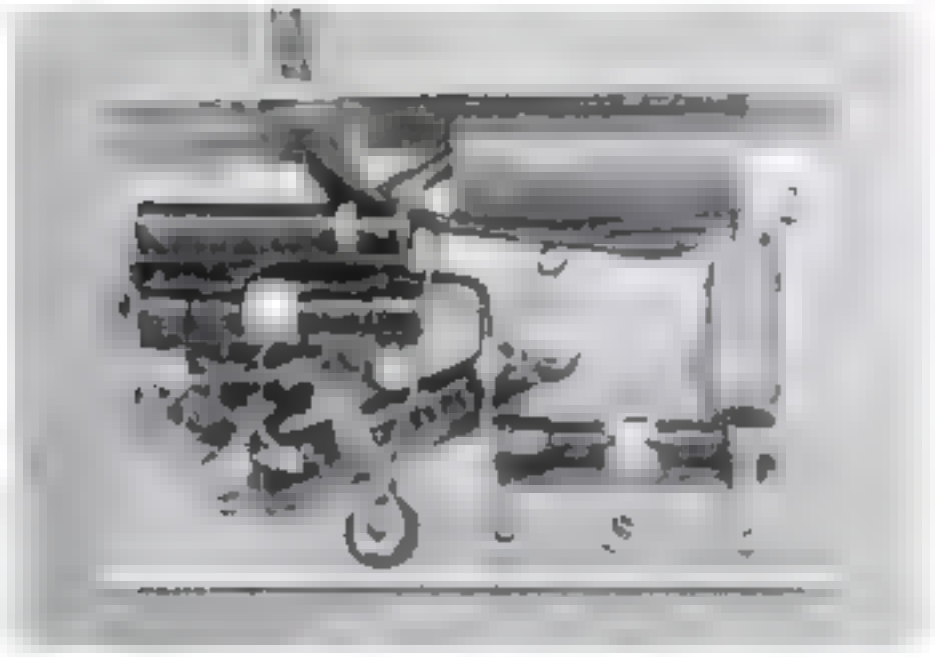


LIST OF PARTS

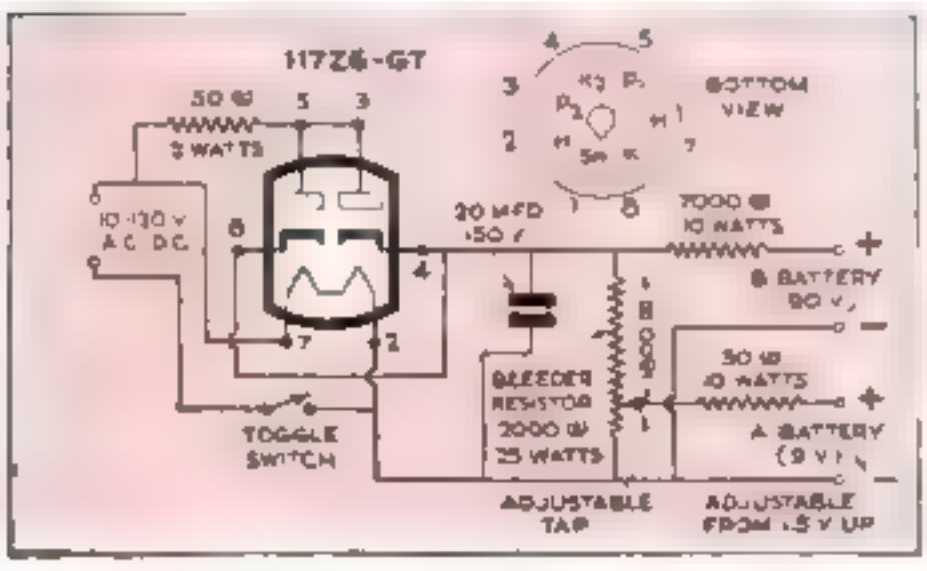
Metal chassis, 1¼" by 3¼" by 4"
Octal wafer socket
Half-wave rectifier tube, 117Z6-GT
Carbon resistor, 2 watts, 50 ohms
Wire-wound resistors (3): 10 watts, 30 ohms; 10 watts, 7,000 ohms; 25 watts, 2,000 ohms
Electrolytic condenser, 20 mfd., 150 v.
Toggle switch, S P S T
Binding posts (4).
Rubber line cord and plug.

Radio Batteries Boosted on Homemade Charger

By ARTHUR C. MILLER



Four resistors and an electrolytic condenser are installed under the chassis, as shown above, with connections made as in the wiring diagram below



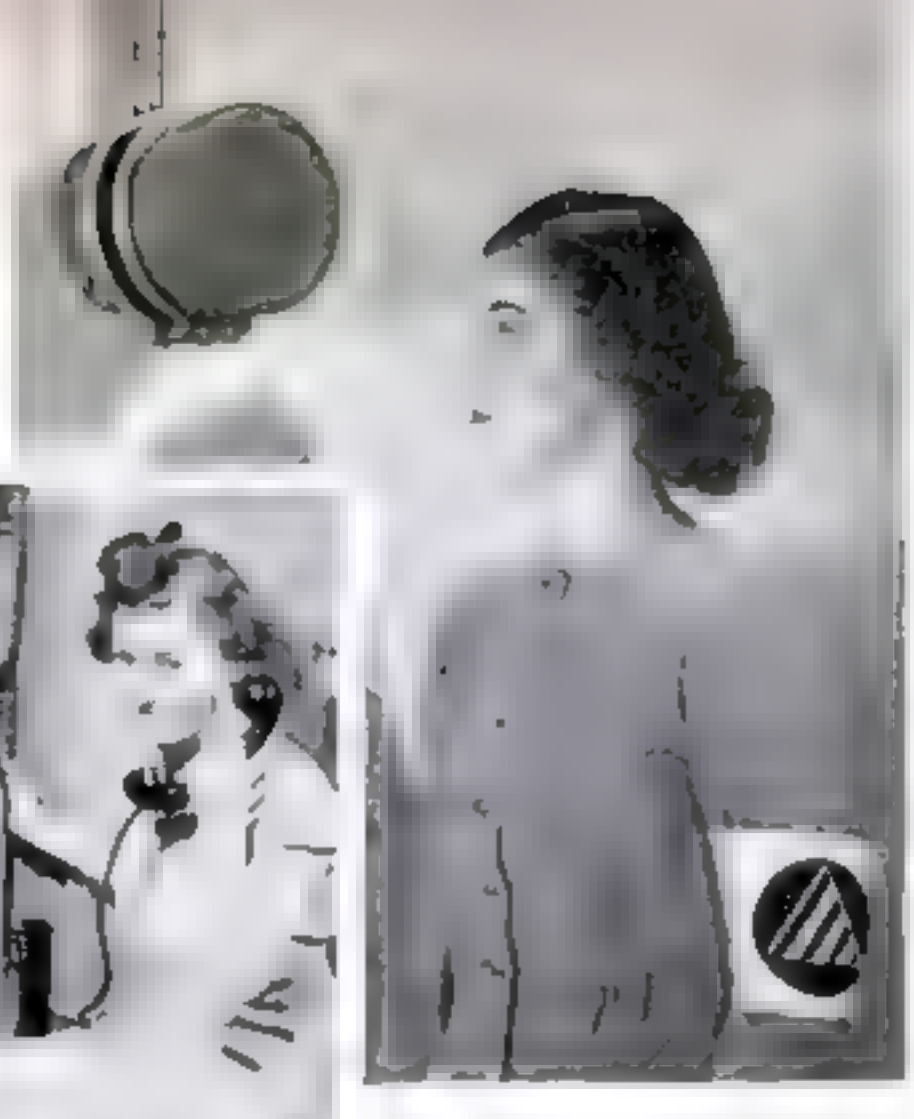
BATTERY life can be lengthened with this home-built charger consisting of a special resistor network and a 117-volt half-wave rectifier tube. Operation is on ordinary household current, A.C. or D.C., 110-120 volts. The circuit is arranged to provide a charging rate equal to about one third of the discharge rate of the average portable receiver having three to five tubes—a ratio found to give best results.

Batteries should be placed on charge immediately after each use, and the charging period should be at least twice the length of time they were operated. This may have to be extended even more as they age. Charging every few weeks, even when the receiver has not been used, is advisable. Be sure the battery terminals are connected to the proper posts to avoid damage.

Wiring connections are made as shown in the diagram at left, with the resistors and condenser placed under the small chassis. The carbon resistor in the plate circuit of the rectifier tube protects the tube and condenser from line surges, which may sometimes go as high as 300 volts if the unit happens to be turned off on a particular part of the cycle.

Radio Ideas

CARRIER-CURRENT TRANSMISSION has been developed to serve civilian defense in the sending of air-raid warnings and similar signals. On getting the proper impulse, the receiving device switches on a buzzer and a colored light. Signals for turning on sirens, controlling street lamps, and the like may be sent simultaneously, since a single power line can carry several different frequencies, including those for voice transmission. Apparatus resembles radio equipment, with energy generated as in broadcast transmitters and received as in home radios.



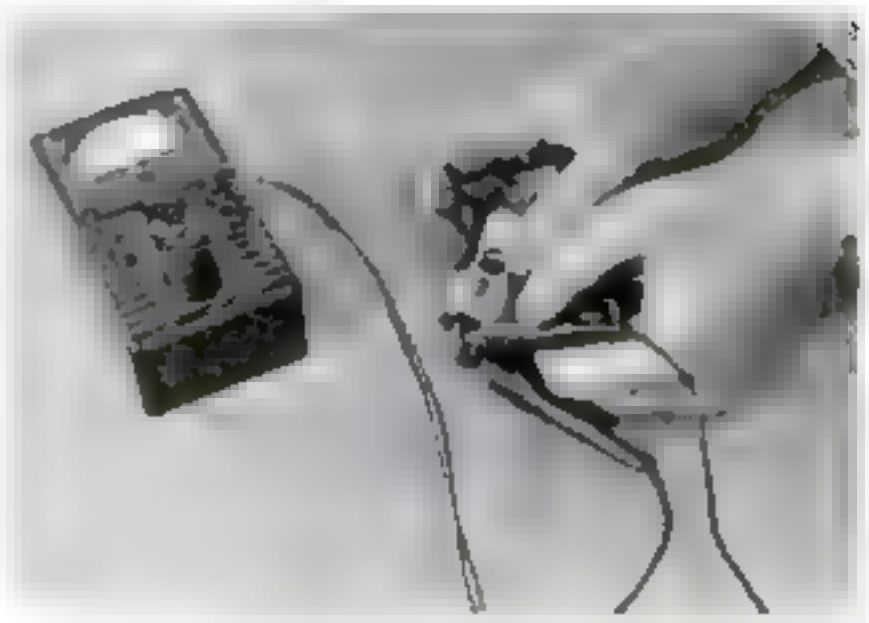
This device, connected in the light circuit is used to signal defense wardens. At left, voice transmission

CHEMICALS AND CEMENTS needed by radio servicemen for the repair of speakers, coils, contacts, dials, controls, and other parts are included in a compact kit of 20 2-oz. bottles on a permanent stand. The bottles are provided with airtight stoppers equipped with glass-rod applicators and contain such universal repair liquids as dopes, contact and crystal cleaners, insulating and other varnishes, special oils, and dressings. Each is kept within sight and quickly accessible on the rack, which may be placed on the workbench or hung on the wall.

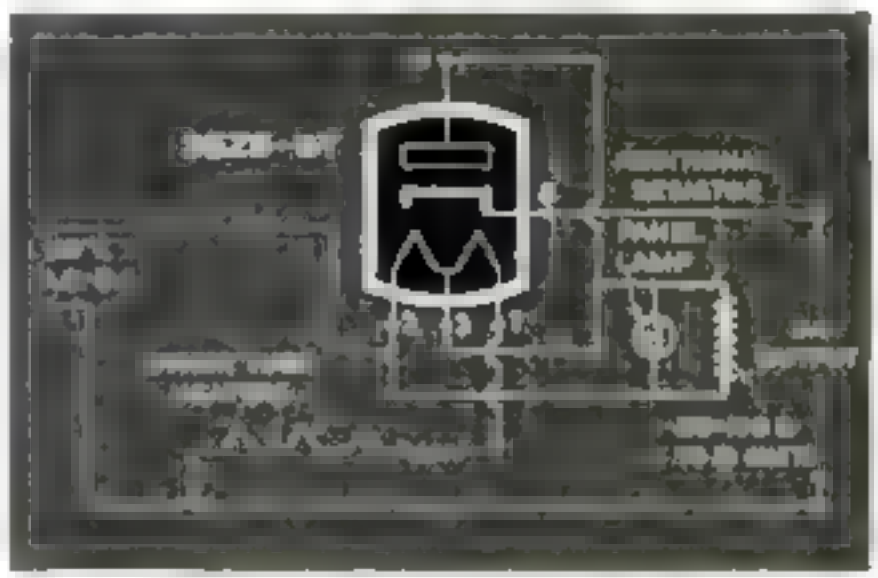
THIS CRYSTAL MICROPHONE is made from a metal sugar shaker and a single crystal headphone. Punch a hole in the bottom of the shaker for the phone cord (there are plenty of holes in the top for passage of voice vibrations) and hold the phone in place inside with cotton wadding. Make a stand of wood, or purchase one at a second-hand supply shop, and attach the shaker to it by the handle. Use at least a two-stage audio amplifier. In connecting the microphone to the amplifier, place a 1-megohm resistor load across the mike in series with a .05-mfd., 400-volt tubular condenser.

Servicing Your Radio

ANY OHMMETER MAY BE USED for testing a radio tube to determine whether its heater is burned out. Simply connect the two test prods of the ohmmeter to the heater or filament prongs on the tube base. If the ohmmeter needle is deflected or moves suddenly to the right of the scale, the heater is good; if there is no movement of the needle, the tube is defective. The No. 2 and No. 7 pins on octal tubes are usually the heater or filament connections, while the duplex-diode-triode detector tubes, such as the 12SQ7 type, have their heaters connected to the No. 7 and No. 8 prongs.



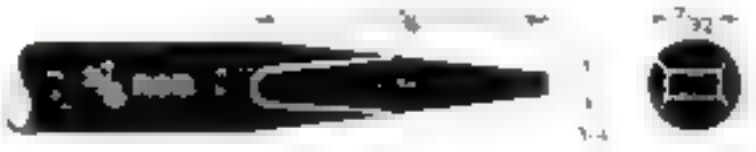
PANEL LAMPS may burn out prematurely on those small A.C-D.C. receivers that use a 35Z5-GT half-wave rectifier but are not equipped with a shunting resistor across the lamp. For a few seconds after the set is turned on, a deteriorating, excessive load is often put on the panel lamp and that portion of the rectifier heater across which the lamp is connected. To avoid this, connect a wire-wound fixed resistor across the lamp or between the No. 2 and No. 3 prongs of the tube, as shown at right. Use an 80- to 100-ohm resistor rated at 5 to 10 watts.



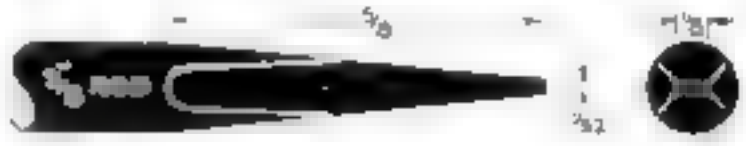
ORDINARY HEAVY THREAD, such as that used for sewing on buttons, can be requisitioned to make an excellent repair when a dial cord is broken. Take a piece of the thread about 1½" to 2" longer than the broken dial cord and pass it around the tuning-knob spindle twice, then about the large metal drum in front of the tuning condenser. Be sure to put it on in the same manner as the old cord. A dial so repaired should operate as well and continue in service as long as it would if the old cord had been replaced with a regular flexible wire made for the purpose.

NOISY WIRE-WOUND CONTROLS often found on old receivers, especially the large console models, can be repaired quickly and adequately with a new chemical lubricant when it is impractical to discard the old controls for new ones. The lubricant is applied with a brush directly to the contact surface of the resistance-wire element. This will eliminate the noise and cause the control to work smoothly even if it is one that has been in use on the receiver for a number of years. The new lubricant can also be used effectively on noisy wire-wound controls and wave switches of the newer models.

Heavy tip suitable for large connections

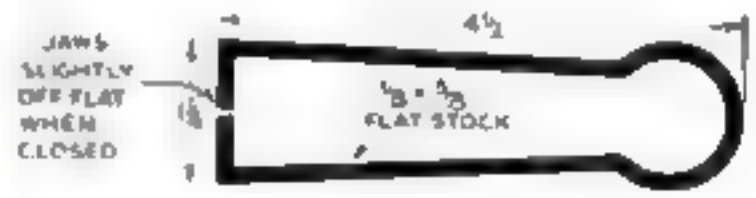


This size point is best for average jobs



Long point for fine work in tight spaces

Sizes and shapes of soldering tips have much to do with making good joints. The three above are the result of analyzing 65 different tips shaped by solderers at a radio plant. An expert rehammers tips to the three standard shapes as at left



Insulation stripper for enameled wire

Pointers on Soldering Electrical

By W. R. SCHALL

Chief Inspector, Stromberg Carlson Telephone Manufacturing Co.

WHEN electrical equipment is being manufactured for war use, the soldering of terminal connections is of great importance, for each such connection forms a link in the communication system of our armed forces.

To make certain that soldered connections will not fail, the Stromberg Carlson Telephone Manufacturing Co., maker of communication equipment, gives its employees a course in soldering technique. Although this course was prepared with special reference to soldering joints in radio and telephone equipment, the principles it outlines apply to any type of electrical connection.

The first thing to consider in making a good soldered joint is the terminal. It must be clean. Solder won't stick to an oxidized or corroded surface. Cleaning a terminal with steel wool or sandpaper will insure its fitness to hold solder. Copper, brass, and even steel can be soldered directly if patience and care are exercised, but if the terminal is coated with tin or cadmium, soldering is easier and faster. Nickel plating must be filed or sanded to make solder hold well.

No soldered joint is good unless the underlying mechanical joint between the wire and terminal is first solid. The function of solder is to seal the joint and to insure a permanent electrical connection. There should be no movement between terminal and wire while the solder is in a mushy state before it solidifies.

The condition of a soldering point is of great importance. For home use, a tip that has become pitted or blackened with burned flux or solder is best cleaned by filing the faces bright and smooth. If the iron is filed when cold, it should be tinned right after it is heated for the first time. If a tip is filed hot, it should be tinned immediately after filing to avoid oxidation. To tin an iron, have it hot enough to melt solder freely. Melt a puddle of solder and flux on a bit of

Connections

Careful soldering of connections on the equipment used in wartime communication systems is vital. An insulated holder (in circle) conserves heat and current. It keeps the iron at a convenient angle

tin plate, and rub all surfaces of the tip in the solder until they are evenly coated.

Both the shank and threads of an electric soldering iron having a removable tip should be free of corrosion and black oxide, which retard transmission of heat.

Flux retards oxidation and promotes the fusion of heated metals. For electrical work, manufacturers use only rosin flux or rosin-core solder. Sal ammoniac or acid flux causes corrosion of the wire and joint, with subsequent failure of the connection. For soldering electric wires, rosin-core solder provides just enough flux at the time the solder is melted to form a good joint in one operation.

Hold a soldering iron flat against both the wire and the terminal. When all portions of the joint are sufficiently hot, touch the solder to the joint and the flat of the iron at the same time; then take the iron away as soon as the solder flows freely.

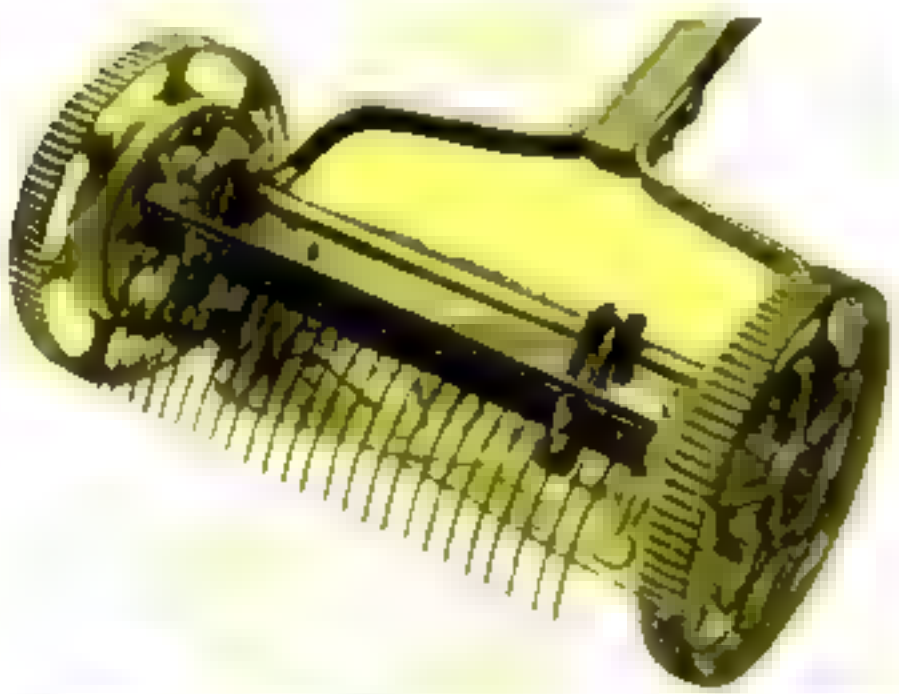
Never try to carry solder on the tip of the iron to the parts to be soldered, because the flux will burn out before the iron gets there. If it is necessary to reheat the connection, use more rosin-core solder or rosin flux.

Sometimes a joint may seem firm yet in reality be held only by hardened rosin or by lumpy, improperly bonded solder. This is due to the terminal being heated insufficiently, or by dirt on the terminal or wires.

A good solderer uses only just enough solder for a job, but if some is splashed off, he will always remove it even though it seems to be stuck fast. Should the loose ends of wires need clipping after mechanical connections have been made, do the clipping before soldering and remove the clippings. Splashed solder or clippings may ruin a piece of equipment if they later get lodged in the wrong place.

When a connection goes through a hole in a terminal, be sure none of the insulation does, and that no end of wire beyond a terminal is long enough to reach to any adjacent terminal. Be careful not to nick wire in stripping off enamel insulation. The stripper on the facing page is safe to use.

CRAB GRASS can be eliminated with a simple rake attachment that clamps on the lawn mower. The rake lifts the seed heads, which the mower then cuts. When not in use, the rake folds out of the way.

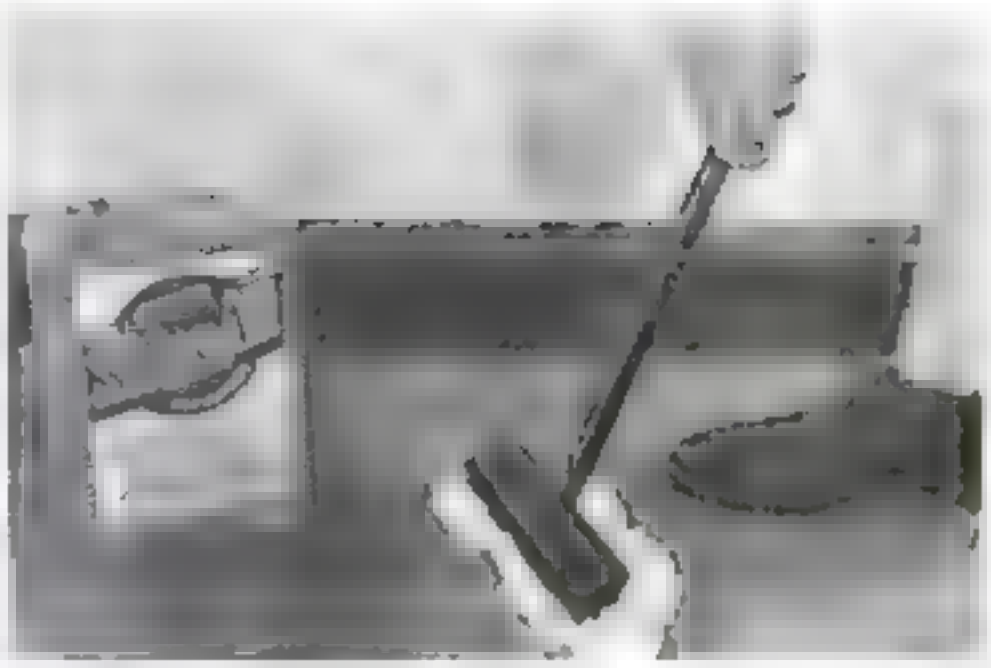


THE BARBECUE SET shown above contains 11 essential sauces and meat seasonings sure to contribute to the success of your barbecue parties. Featured is a 16-oz. bottle of old-fashioned barbecue sauce. Worcestershire and Swiss sauce are also included in this mouth-watering condiment set, which is attractively put up in a log-cabin type wooden tray that can also be used for serving.

PLASTIC TANK FLOATS are said to be a definite improvement over former types made of copper or other critical materials. The tough, corrosionproof plastic will not dent or open at the seams, the latter being securely cemented. Because of the extreme lightness of the floats, shipping weight in quantities is greatly reduced.

EXCESS HUMIDITY and dampness inside cause a great deal of damage in many homes. The package at the left contains a harmless chemical that absorbs excess moisture from the air in confined places such as closets, pantries, basements, lockers, and the like. The chemical causes the moisture from the air to collect in the lower part of the container.

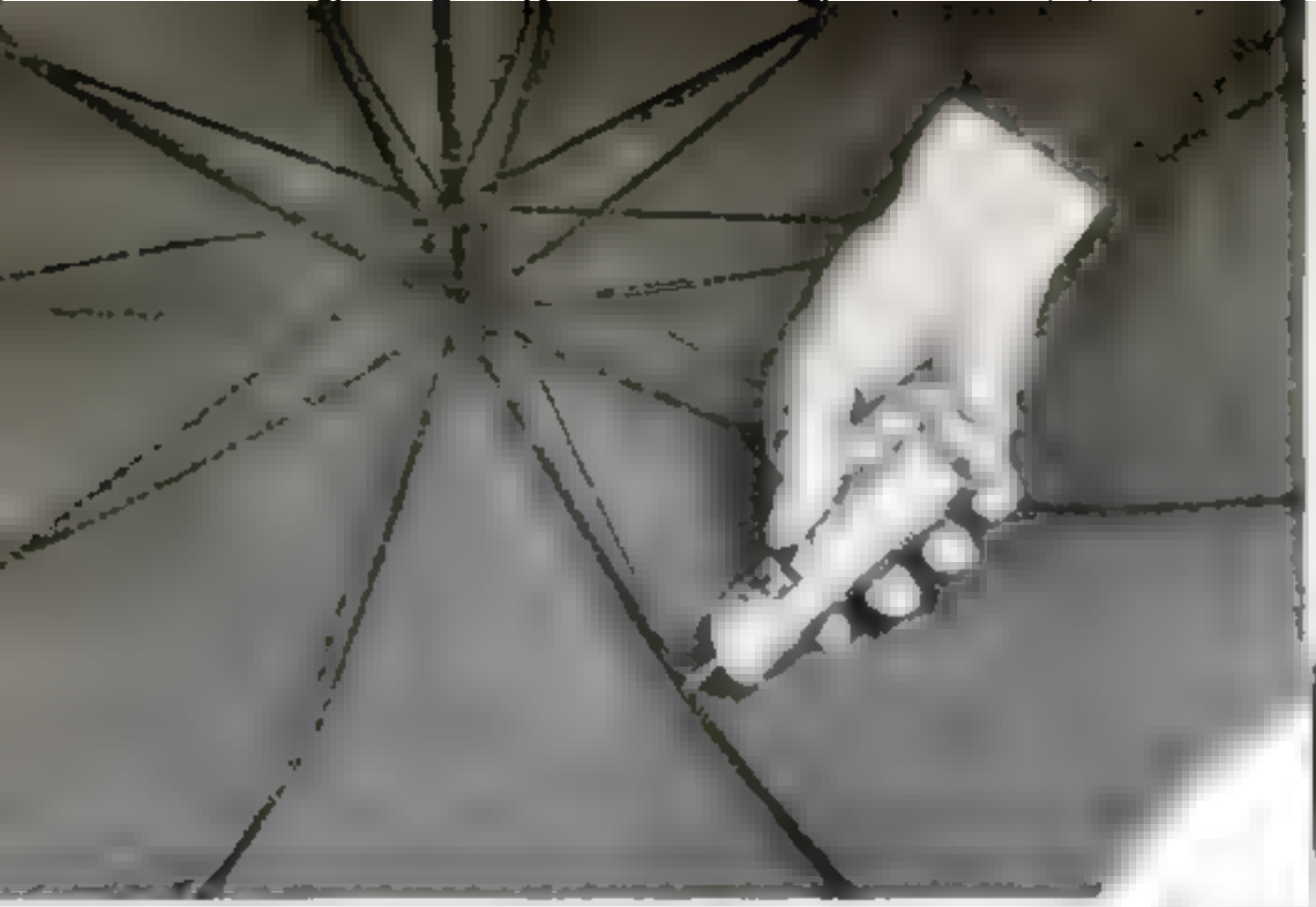
A FLOOR CLEANER that also polishes and preserves floors is now on the market. An ounce of the chemical cleaner is dissolved in about a gallon of warm water. The solution is stirred, and a small area of the floor is gone over lightly, after which the mop is wrung out and used to dry the moistened area. This is continued until the floor has been completely covered. Afterward it can be polished to a warm glow. The cleaner is effective on wood and tile floors, and can also be used on any other surface which water does not harm.



PLASTER KNIFE OF PLASTIC. Molded entirely of one piece of a special plastic material, the plaster knife below is made without steel. Although the edge of the plastic blade is only 1/16" thick, it is said not to break or chip in use. The handle is designed to fit comfortably in the palm of the hand and, since it and the blade are molded in one piece, will not pull off or twist as sometimes happens with the former type. The over-all length is 7".

ASBESTOS SIDING SHINGLES requiring no face nails have been developed. They can be used for repairing as well as for new work. Felt backer strips to keep water and moisture from penetrating at the joints are supplied with these shingles. Extensive tests have revealed them to be satisfactory, and the absence of face nails is said to enhance the appearance of the finished job. The shingles are 12" by 24", and 66 are required to the square.

WOODEN DOOR HINGES may take the place of metal ones. Each set of hinges, such as the ones shown in the accompanying photograph, consists of four hardwood plates, one wax-impregnated dowel or pivot for the upper hinge, one ⅝" glass supporting ball for the lower hinge, and 12 flathead screws. The hinges are easily attached with the help of a saw, a drill, and a screw driver Simply saw notches to accommodate the plates in the top and bottom of the door, and use the screws to mount the various parts. The hinges, which are of hard maple or birch, come unpainted and may be enameled to match the door or simply finished with varnish and wax.



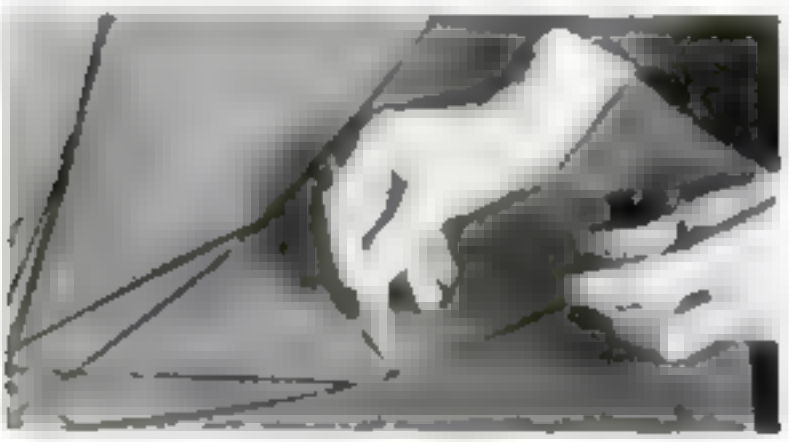
Rusted or corroded ribs are the real cause of a great deal of umbrella breakage, and the best preventive is careful oiling of the joints

A loose handle is annoying, but the stem can be reset by pouring in melted rosin

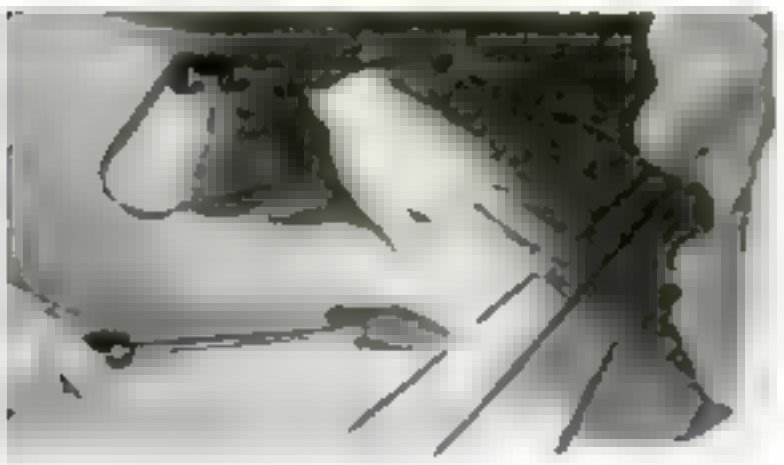
Umbrella Care

PAYS DIVIDENDS IN LONG USE

Should the flexible wire holding the ribs be in bad condition, new wire can be threaded in



Enameling the ribs with a fine brush will be helpful in prolonging the life of an umbrella



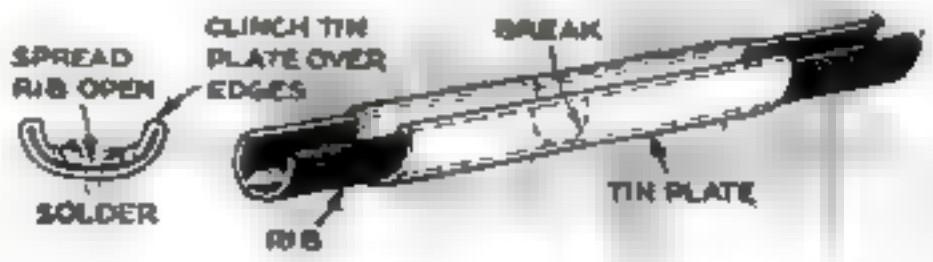
WAR production restrictions have limited the manufacture of umbrellas to such an extent that the care of those you now have becomes a matter of some importance. Not only have wartime restrictions cut manufacturing down to less than 10 percent of its normal volume, but they have also curtailed the variety of sizes and shapes.

A few precautions, however, will greatly stretch the life of an umbrella, and if one needs re-covering either because of wear or in order to match the color scheme of wearing apparel, even that job isn't too difficult. To re-cover an umbrella, carefully remove the old covering to use as a pattern.

When opening an umbrella, first hold it down and give it a twisting shake to loosen the covering and free the ribs from any binding. The umbrella will all but open itself, and any excess strain on the ribs will be avoided. A thorough occasional brushing of the fabric is a help in lengthening its life, as the action of rain tends to work dust and dirt into the fabric and hasten deterioration

The joints in the umbrella frame are subject to rust and, if in this condition, they do not work freely and may cause a buckle. Prevent rust by applying a drop of light oil on each joint. To avoid staining the fabric of the cover, hold a piece of

A broken rib can be repaired with a piece of thin tin bent and clinched over the rib, neatly soldered, then enameled



cloth or paper under the joint to absorb excess oil that may drip from it.

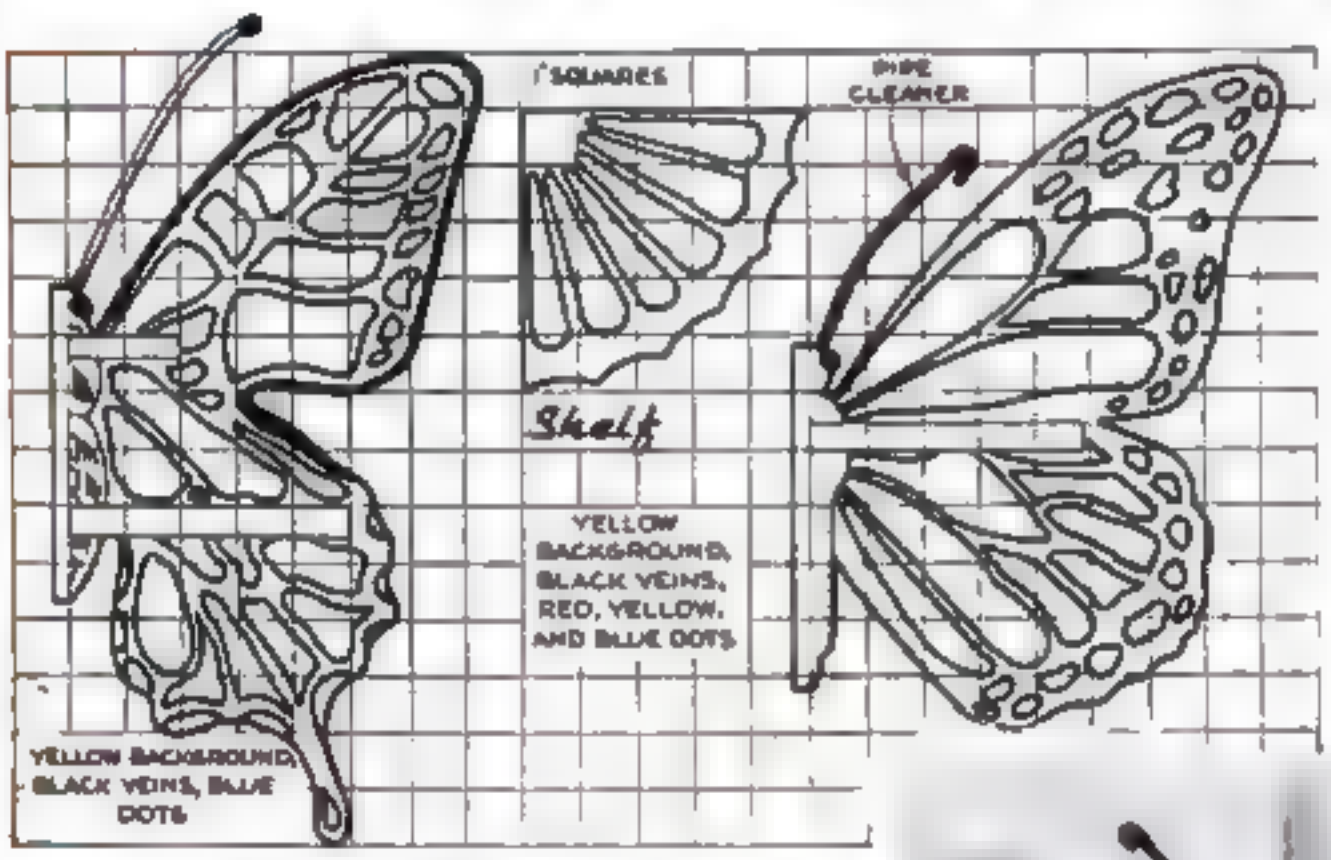
If the wire at the sliding joint breaks or upon examination proves to be near breaking, a new wire can be threaded in. The twisted ends should be carefully bent inward to avoid tearing of the fabric when the umbrella is closed. Should a rib break, it can be replaced or repaired. To replace, cut it loose from the fabric; don't attempt to pull it out, for its rough ends may ruin the covering.

Repairing a broken rib is done by using a small piece of light tin plate bent as shown in the drawing. The edges are clinched over the rib and then soldered. Such repairs, as well as rusted spots, should be touched up with quick-drying enamel. Use a small brush to avoid staining the fabric. Repair parts may be difficult to buy, but in most cases they can be salvaged from an umbrella that has seen its best days.

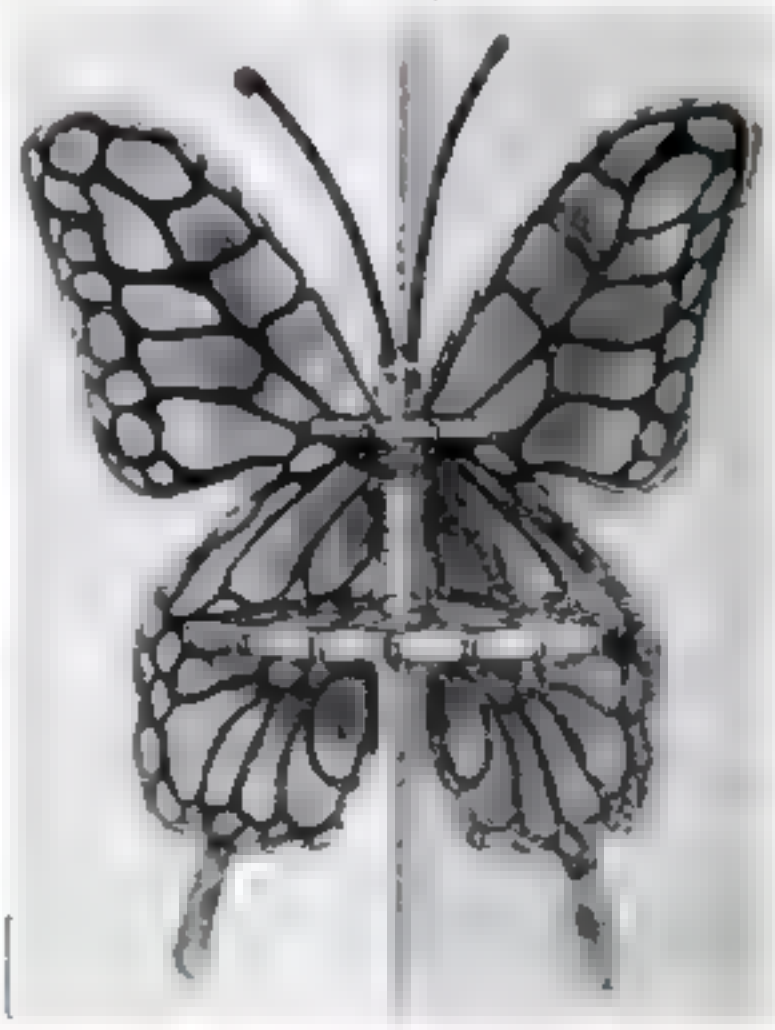
Handle repairing is part of umbrella upkeep. To reset a loose handle, melt some rosin and pour it into the joint. Another good handle cement can be made by mixing glycerin and litharge, both of which can be purchased at a drug store.

A satisfactory way to hold the umbrella while doing many of the repairs is to put the tip in a small hole bored in the top of the workbench. This allows the umbrella to stay in a half-opened position, which makes it easy to work on.—BENJAMIN NIELSON.

Gay Butterfly Shelves for a Child's Room



Vividly colored butterfly wings on this shelf brighten a room



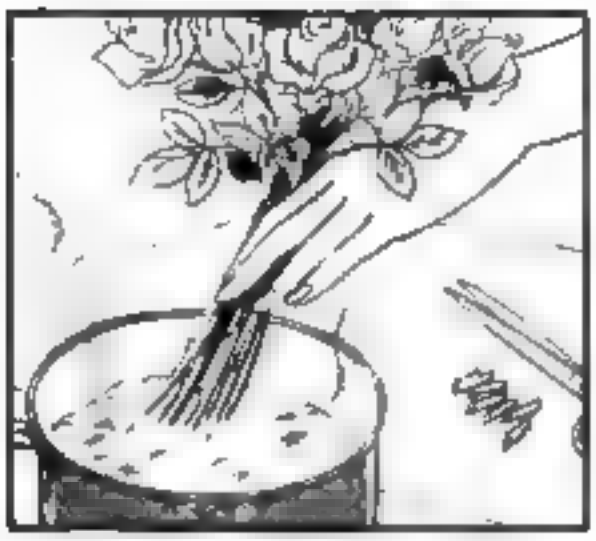
CORNER shelves designed and colored to look like giant butterflies are especially appropriate for children's rooms. Two designs are given above. Lay out either on squares, or copy a suitable butterfly and its coloring from an encyclopedia or dictionary.

Two wings for each shelf are jigsawed from ¼" plywood. Miter the joining edges, or make one wing ¼" wider and assemble with a butt joint. Shelves are of ¼", ⅜", or ½" stock.

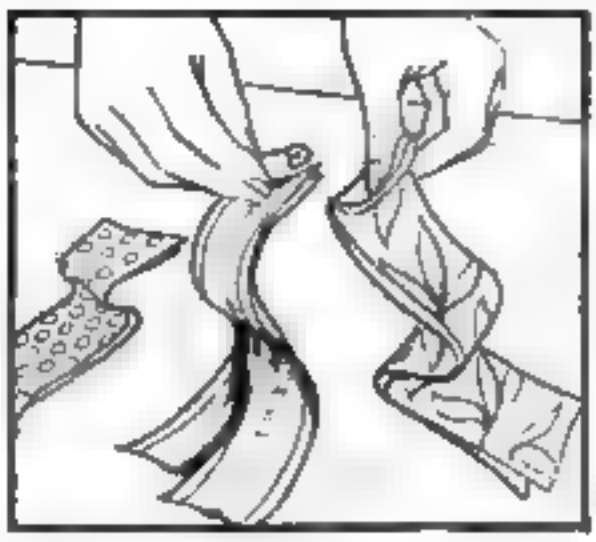
The wing parts and shelves are put together with small screws and glue.

Antennae, made of pipe cleaners with the ends bent or curved spiralwise and dipped in paint, are glued into small holes. A screw eye in the head serves as a hanger.

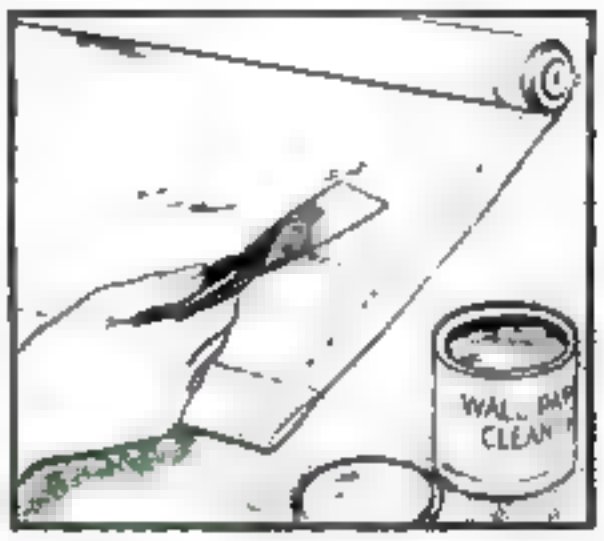
The butterfly is first painted with the predominant color, and the markings are applied afterwards.—J. ROGER DARLING.



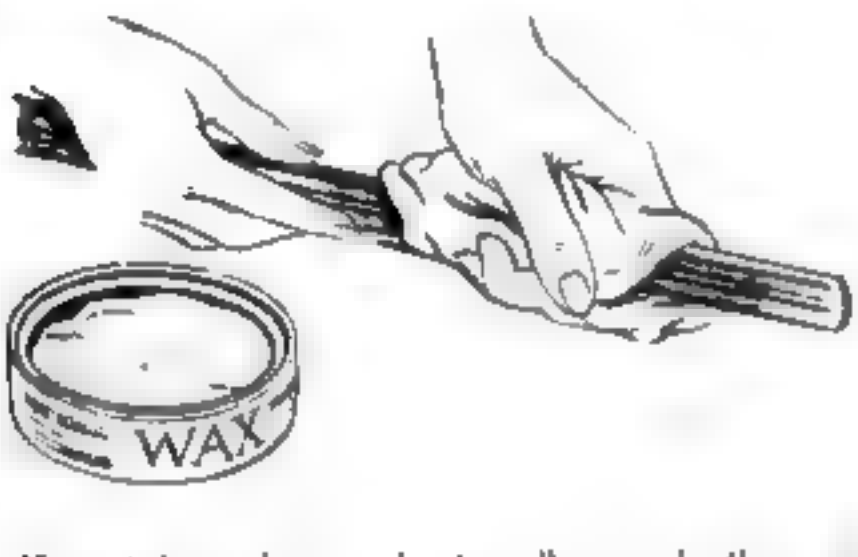
Flowers can be kept fresh longer if the stalks are trimmed, then qu'ckly dipped into bo ling water



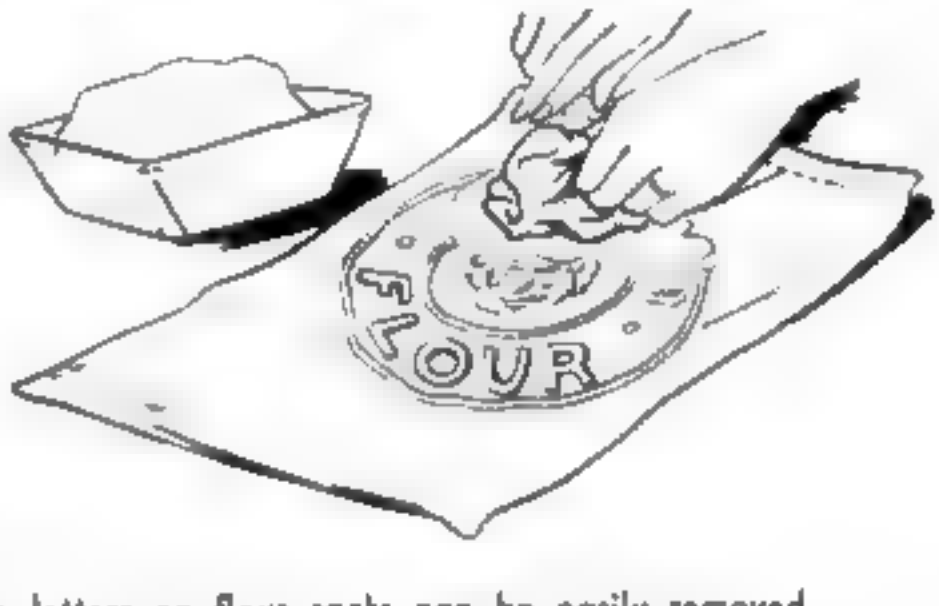
To keep tie-backs of curtains together in laundering, thread them all on a large safety pin



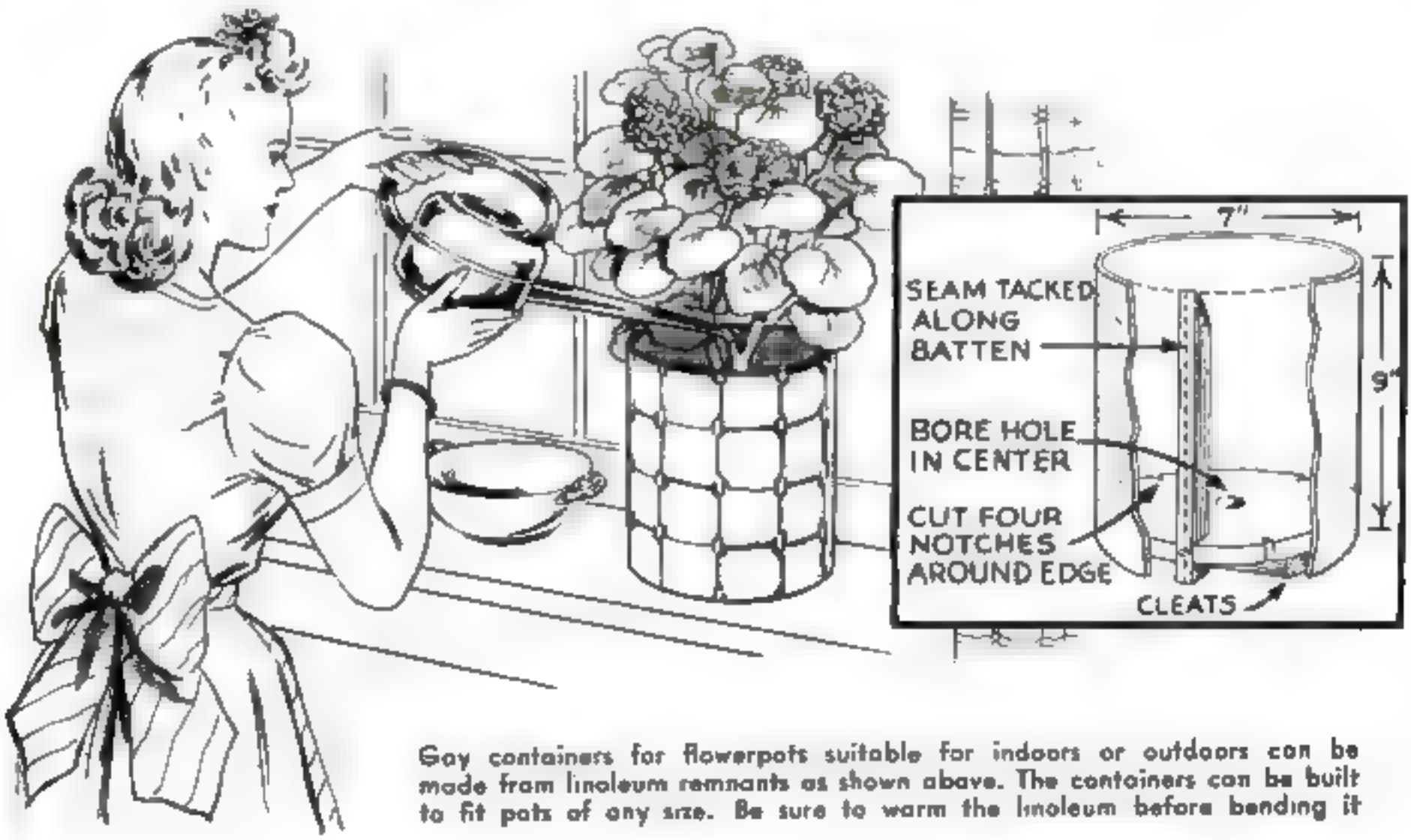
Wall paper cleaner applied on window shades will clean them and insure much longer service



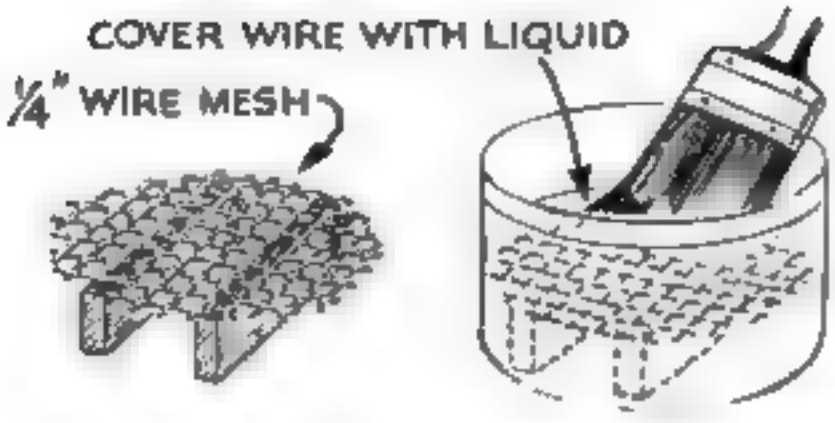
If curtain rods are kept well waxed, they will be less likely to rust. The wax also permits the curtains to slide along them more easily



The letters on flour sacks can be easily removed if you rub them well with lard, let stand for several hours, then launder in hot sudsy water



Gay containers for flowerpots suitable for indoors or outdoors can be made from linoleum remnants as shown above. The containers can be built to fit pots of any size. Be sure to warm the linoleum before bending it



Paintbrushes can be cleaned by placing a circle of wire mesh on two blocks in a can of cleaner and rubbing the brushes briskly across the mesh

Fig 1

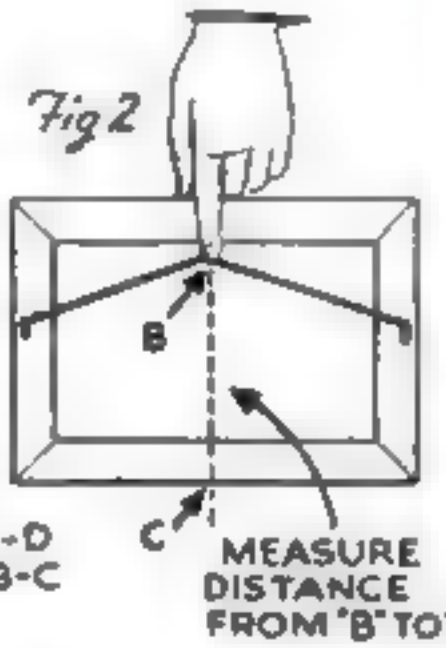


Fig 2

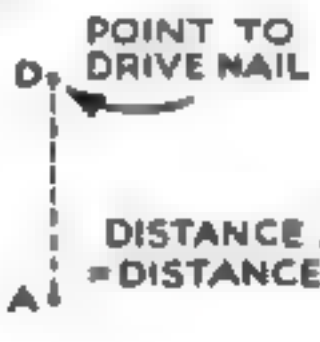
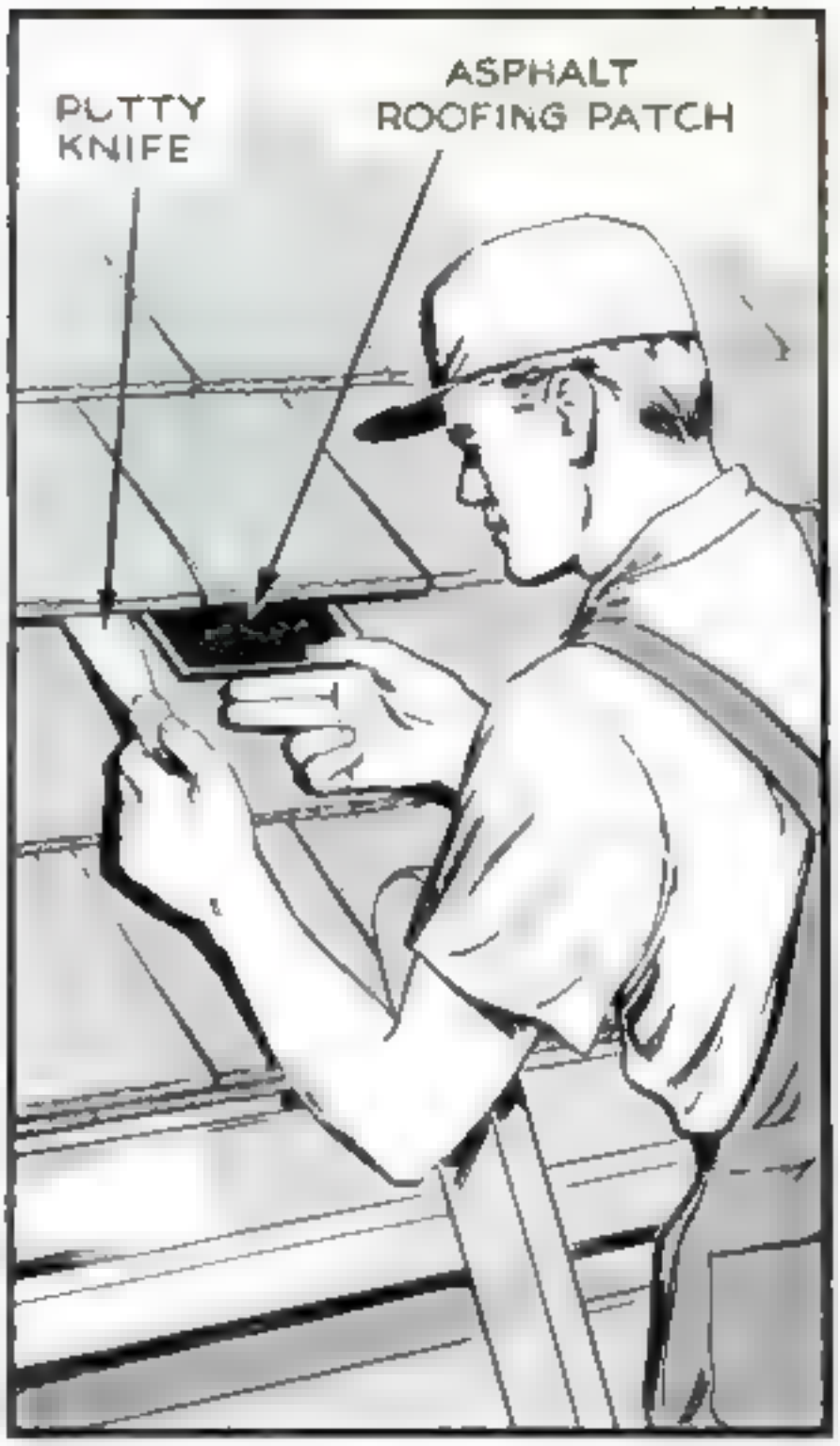
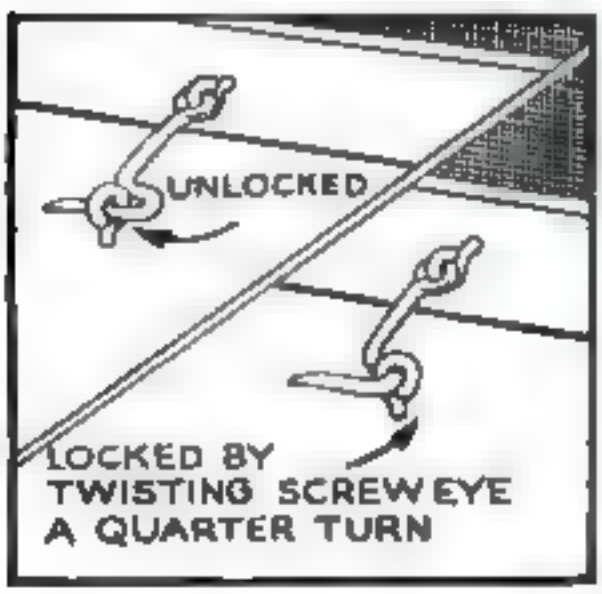


Fig 3

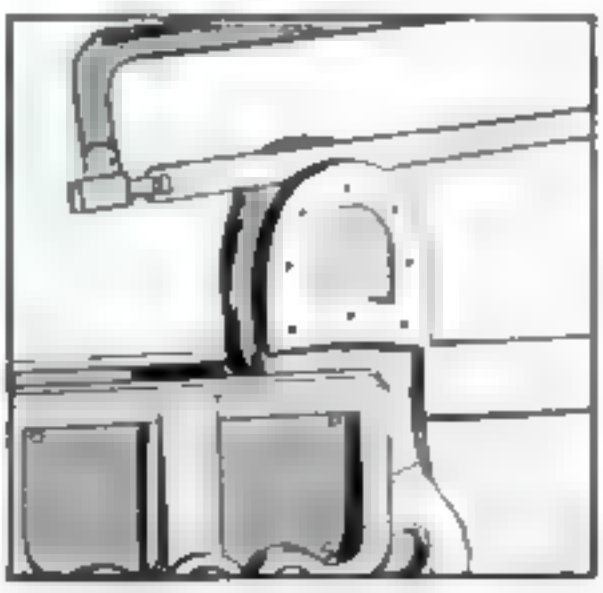
If you follow the directions shown in these three diagrams, you will be able to hang pictures at exactly the desired height. This method is very good for hanging pictures side by side on the wall either in alignment or in a stepped arrangement



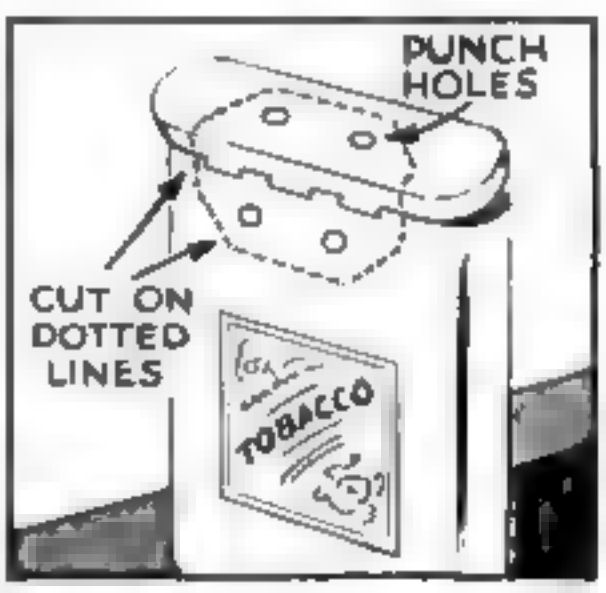
Wood-shingled roofs can be patched with slips cut from ordinary asphalt roofing. Using a putty knife, raise the shingle just far enough to allow the slip to be pushed into place. The sun will melt the asphaltum sufficiently to stick the patch in place. No nails are needed. The patches do not show, for the slip shingles cannot be seen after they are put in place



Outside window screens can be locked in place by twisting the screw eye a full quarter of a turn over the hump of the hook



Rubber heels can be salvaged from old shoes by clamping the shoes in a vise and cutting the nails through with a hack saw



A satisfactory pair of hinges for use on small boxes, cabinets, and the like can be cut from two old-style tobacco cans

Directly above cupric acid and powdered charcoa are ground together The mixture is than put into the horizontal test tube shown in photo at top of page, where the reduction process is demonstrated

CARBON
FOUNDATION OF LIFE
Most Prolific of Elements, It Is Found in All Animal and All Vegetable Tissues

CARBON may well be called the central or pivotal element of the whole organic world. It enters into the formation of more compounds than any other element, and it is found in all animal and vegetable tissues, and in a great many minerals. Indeed, this prolific element might well be considered the foundation of life itself.

Carbon is found in the bodies of animals and plants in the form of sugars, starch, fats, oils, and cellulose. It is found in the form of hydrocarbons in petroleum and natural gas. It is an important component of alcohols and ethers, and is even present in the air as carbon dioxide! As a carbonate, such as calcium carbonate, it is abundant in substances like limestone, marble, coral, and chalk. It exists in a free state in diamonds and graphite. It is not an exaggeration to say that carbon can be found everywhere in nature—in land, in air, and in water. The soot that collects on your clothing is a form of carbon. So are the smoky fumes that issue from the exhaust of your car!

From simply one form of carbon — the coal you use for fuel—comes an almost countless array of materials, including illuminating gas, fertilizers, explosives, photographic developers, medicines, and dyes. All of these products originate in the compounds that are distilled off and collected when coal is heated without air.

Although it would be difficult for the home chemist to produce most of these by-products in their final form, you can easily make illuminating gas and coal tar, and show the presence of ammonia and sulphur, by the destructive distillation of coal.

For these experiments it is best to use soft coal, as it contains more volatile matter than the hard or anthracite type. Break a lump into small pieces and put it into a heat-resisting test tube. Clamp this tube in an almost horizontal position as shown in the photo on the facing page. Through a one-hole stopper run a delivery tube nearly to the bottom of a vertical test tube, the latter serving as a condensing tube. From near the top of this condenser lead out a bent glass tube drawn to a jet at its upper end.

Heat the coal, first gently and then strongly, with a Bunsen burner, using a wing top to spread the flame. After a few minutes hold a strip of paper, moistened with lead nitrate solution, near the tip of the improvised gas jet. The dark spot which will appear on the paper indicates the presence of sulphur, in the form of hydrogen sulphide. Next, hold a strip of paper moistened with a solution of phenolphthalein and a drop of water over the jet. A pink spot appears on the paper, indicating that ammonia is present in the gas.

To prove that illuminating gas is issuing from the jet, apply a lighted match to it. Let the gas generate for several minutes before trying to light it, to drive out all air. Now look in the bottom of the condensing tube and you will see a dark, oily substance. This is coal tar, proud parent of hundreds of coal by-products. What remains in the glass tube after all the gas has been driven from it is coke, an almost pure form of carbon.

Millions of years ago, coal itself was living vegetable matter, and its relationship to present-day vegetable materials may easily be proved. Heat chips of wood or sawdust in your test tube, in place of coal, and you produce charcoal, which is chemically identical with coke. Heat samples of sugar, starch, and bread over your Bunsen burner, and in each case you again produce carbon. Thus white sugar and black coal turn out to be close relatives in a chemical sense.

The most important chemical use of charcoal and coke is in extracting metals from their oxides. Enormous quantities of iron, copper, and zinc are produced with the aid of these forms of carbon. The ores are generally mixed with coke, and the mixture is heated. Oxygen from the oxides combines with the carbon, and the free metal remains. This process is called *reduction*, and it may be vividly demonstrated by means of a simple experiment.

Grind together thoroughly in a mortar about 5 grams of cupric oxide and 1 gram of powdered wood charcoal. By means of a folded strip of paper, pour the mixture into a hard-glass test tube, which should be

Illuminating gas and coal tar are produced at left by heating lumps of soft coal in a test tube. At right below, lead nitrate paper shows the presence of hydrogen sulphide

Because of the highly adsorptive power of charcoal, shown above, it is used in gas masks and in filtering liquids

mounted almost horizontally. This tube should be fitted with a one-hole stopper carrying a delivery tube which dips into another test tube containing limewater.

Heat the mixture in the horizontal tube, first gently and then strongly, as you did in the first experiment, for at least 10 minutes. Presently the mixture will become red-hot and glow like a miniature inferno. At the same time, gas is liberated. The gas bubbles up through the limewater in the second tube, turning it white. This whiteness is due to microscopic particles of calcium carbonate, precipitated by the reaction of the gas—carbon dioxide—with the calcium hydroxide of the limewater. Carbon dioxide is the product of the reaction between the carbon and the oxygen stolen from the cupric oxide.

Continue heating for several minutes after the mixture begins to glow; then allow to cool. Pour out the contents on a piece of paper. Bright crystals of metallic copper will be found mixed with the carbon that was not consumed.

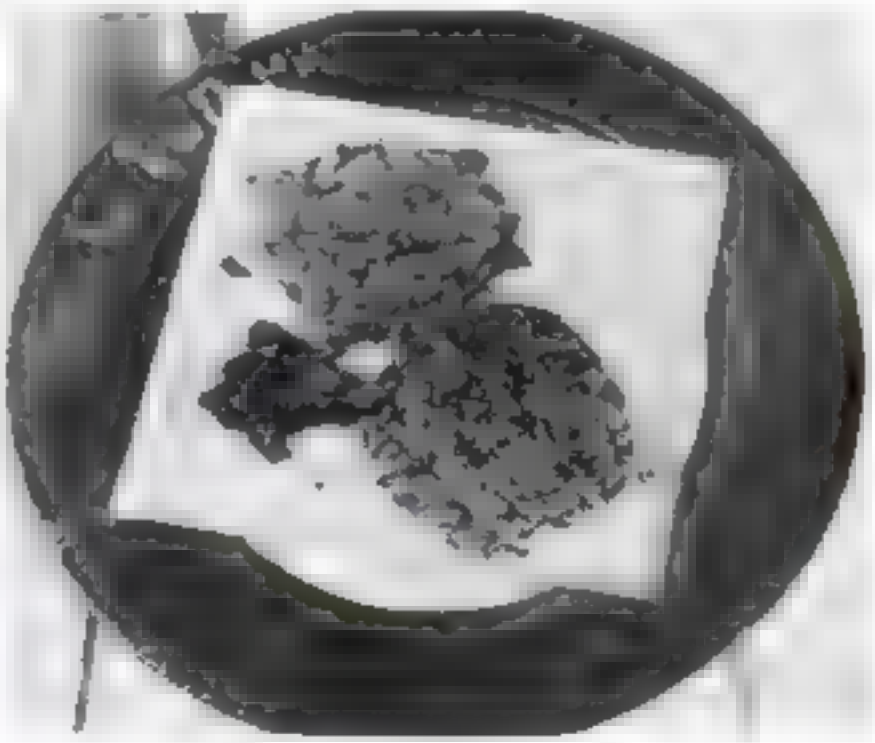
The charcoal form of carbon has still another important use in chemistry, a use which depends upon a physical rather than a chemical property. Finely divided, heated, and chemically treated bits of charcoal have an exceptional capacity for *adsorbing* gases and pigments on their surface. If you have made experiments in sugar chemistry, you probably found that charcoal or boneblack could remove most of the color from a brown sugar solution, the coloring matter of the sugar adhering to the surface of the charcoal.

Similarly, it can cause gases to condense on its surface, adsorbing them from the air, and because of this it is used extensively in gas masks. You can demonstrate this property by a simple stunt.

Pour a little concentrated ammonia water into a small flask and on top of it toss a piece of crumpled tissue paper. Sprinkle some powdered charcoal on the paper. Now close the bottle quickly with a stopper having a tube leading from it into a glass containing colored water. The charcoal will adsorb some of the ammonia gas liberated in the flask, as attested by the rise of colored water in the tube.—KENNETH SWEZEY.

Below, three distinctly unlike materials—sugar, starch, and a piece of bread—are placed over a Bunsen burner, where they are all gently heated

Now see what happens when these three substances are heated, as in photo below. Hydrogen and oxygen are given off and what remains is—carbon!



home EXPERIMENTS

THE FORCE OF INERTIA can be demonstrated by suspending a weight, as shown, with a piece of string only slightly stronger than is necessary to hold it. As a safety measure, tie a second, heavy cord with a little slack in it to the top of the weight. A string the same size as the first top string is tied to the bottom of the weight. You can, by pulling on the lower string, break either this or the top one at will. To break the bottom string, give it a quick, strong jerk. The inertia of the weight will prevent the impact of the jerk from reaching the top string. Pulling steadily on the lower string will break the top one, which is subject to your pull as well as to that of the suspended weight.

WHAT HAPPENS when you cut through an ice cube with a wire? Try this experiment and see for yourself. Mount an ice cube on top of an inverted dish and pass a thin wire through it, using considerable pressure. When the wire has gone completely through the cube, you will find the ice still frozen together as solidly as it was before. why? The pressure on the wire melts the ice beneath it, borrowing the necessary heat from the adjacent ice. This loss of heat from both sides of the ice cools it enough to enable it to refreeze the water remaining behind the wire.

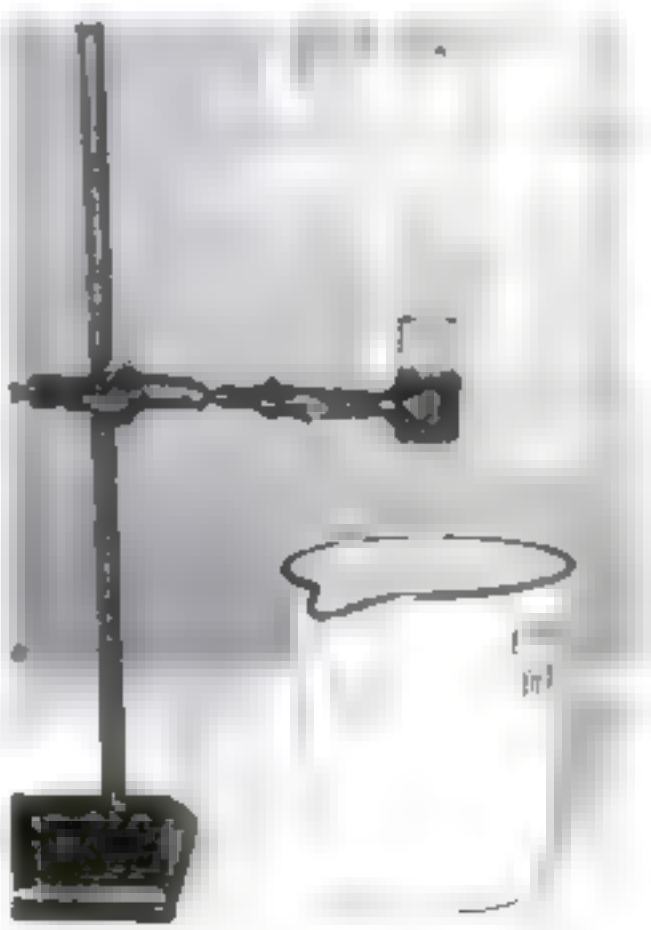
BALANCING STUNT. Hold a carpenter's rule of the type shown over the edge of a table with the hinge side underneath, and the outer end of the rule will naturally drop down. But with a little care you may hang a hammer on the far end of the rule and so make that end stand out horizontally. Place the loop of thread as shown in the photo. The hammer acts as a lever exerting a *lifting* force against the end of the rule. The greatest weight of the hammer being in its head, the center of gravity comes under the table.

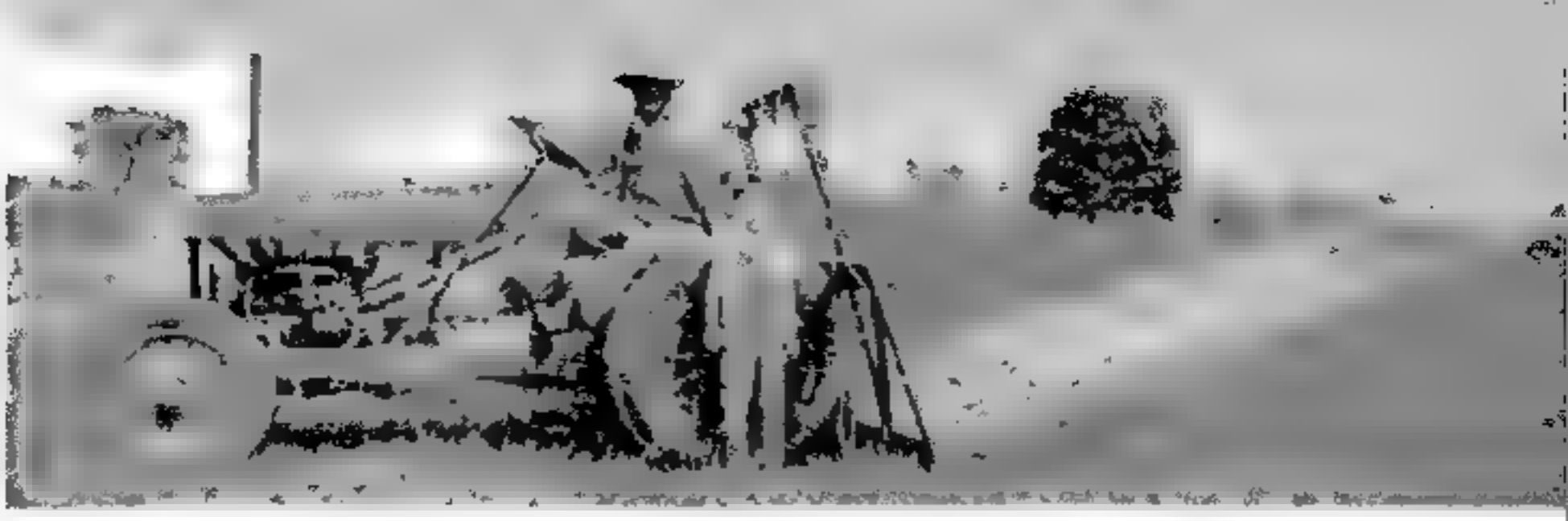
PRESSURE PARADOX. Construct three vessels of paraffined cardboard, all with bases of exactly the same diameter. The upper parts of them should vary in diameter as shown at the right. Tie and glue a piece of rubber from a balloon across the bottom of each. Now clamp the funnel-shaped vessel so that the rubber just touches the platform of a letter scale. Pour water into it to a height of 3" and note the reading on the scale. Fill the other two vessels with the same amount of water in the same way, and you will find that the scale indicates the same reading in each case, for pressure depends only on the area of the bottom and the height of water above it.

MYSTERIOUS LIGHT BULB. When placed in *cold* water it floats, then sinks. When placed in *warm* water, it sinks, then floats. To perform this stunt, weight the base of a bulb with wire until it will just barely float when placed in cold water. When the weight is just right, you will find that the bulb will sink to the bottom after floating for a short time. Place the same bulb in warm water, and it will sink immediately, but after a few seconds will rise to the top. The explanation is simple. When you put the bulb in cold water, it floats until it contracts on cooling, whereupon it sinks to the bottom. The contracted bulb, placed in warm water, will stay at the bottom until it expands; then it rises to the top.

WHY WATER PIPES BREAK in the winter may be demonstrated with a test tube filled with water. Stopper it tightly. Now place the tube in a mixture of cracked ice and salt. As the water in the tube freezes, the stopper will be pushed out. If the stopper is wired down so that it cannot be pushed, the whole tube will break. Even bombs made of heavy cast iron may be exploded by water freezing inside them, so it is no wonder that pipes and auto radiators burst if ice is allowed to form in them. The reason is that water expands with terrific force as it freezes.

THE REASON ICE FORMS on airplane wings when the plane passes through cold, dry, winter clouds can be shown in a rather unusual experiment. Pour some water in a clean test tube, put a thermometer in the water, and pack a mixture of salt and ice around the tube. If the tube is left undisturbed and not jarred while the water is allowed to cool, a strange thing happens. The water reaches the freezing point, but does not freeze! However, if the tube is jarred a little, or if foreign matter is placed in it, the water will freeze almost instantly. This is what happens when a plane travels through a cold winter cloud. The moisture in the cloud is supercooled but not yet frozen. The plane, rushing through this supercooled moisture, turns it suddenly into ice, which forms on the fuselage and wings.





Unique Sweep Rake Attached to Tractor Saves Labor in Haying

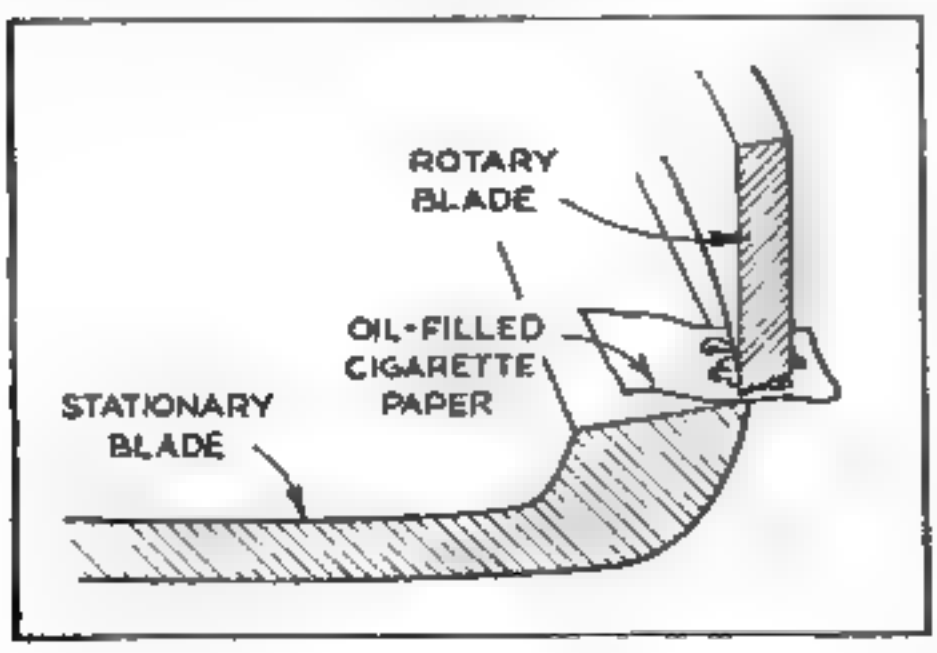
FACED with a shortage of help, Earl Saum, of Fremont, Mich., devised a buck rake, or sweep rake, that cuts by one third the number of man-hours formerly required for haying on his farm.

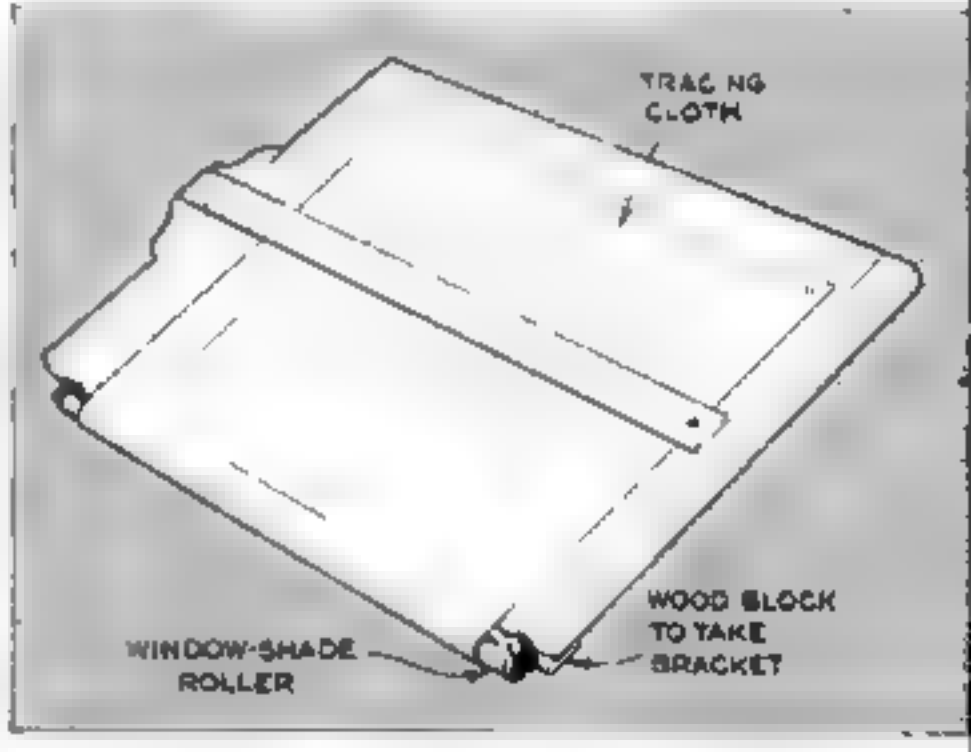
The rake is 10′ long and 10′ wide. Its 10 tines are made of five 2" by 6" pieces of white pine ripped at a taper to be 2" wide at one end and 4" at the other. The crosspieces are 2" by 6" oak stock used full width. Two 3½" by 3½" angle irons are bolted to the frame of his homemade tractor so that they come out even with the rear tires, and the rake is attached by hinges to these angle irons. The tractor was put together from an old passenger-car frame and motor and a rear end and gears from a 3½-ton truck.

The outfit is backed into a windrow of hay until it is fully loaded. A crank raises the rear of the load, which is hauled to the barn without handling. The load is backed into the barn and slid off onto a 20′ rope sling spread out on the barn floor. This sling is then wrapped over the hay, and the load is pulled up into the mow. A round trip for the outfit on a haul of 300 yds. takes about 15 minutes.—HARRY L. SPOONER.

Oiled Cigarette Paper Helps in Setting Mower Blades

A PIECE of cigarette tissue may be used to advantage for quick and accurate adjustment of the stationary blade of a lawn mower. Impregnate the paper with machine oil, place it on the stationary blade at one end, and turn the rotor until a blade is directly over the covered edge. Tighten down the rotor on this side with the adjusting screws. Turn the screws slowly, watching the paper closely, and when the descending blade presses down on the paper, you will see a thin line of oil oozing from between the blades. When this occurs, the adjustment at this end is just right. Move the paper to the other end of the blade and repeat the process.—W. C. WILHITE.





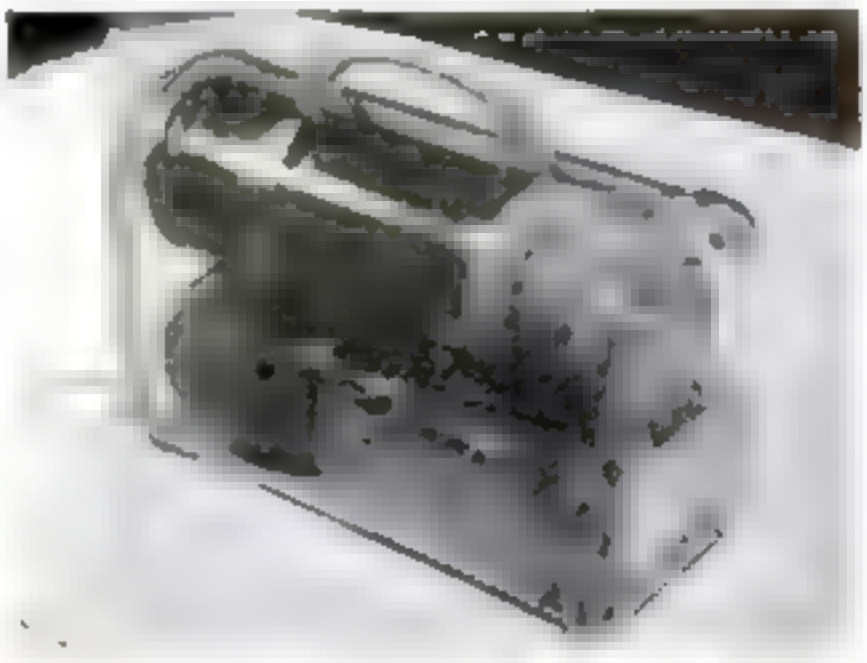
Window-Shade Roller Holds Long Drawings on Board

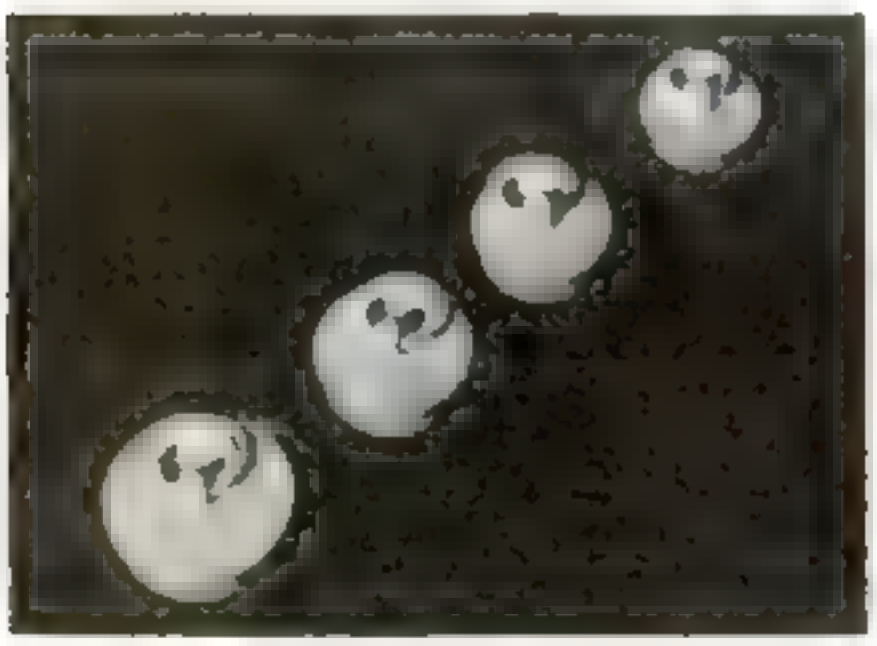
DRAFTSMEN often find it hard to work with oversize drawings that are longer than the board itself. To overcome this difficulty, a window-shade roller of any length desired is fastened to the near edge of the drawing board by means of wooden blocks. One end of the tracing cloth or paper is tacked along the roller and rolled up until that portion not wanted on the board is out of the way. Another roller can be attached to the opposite edge of the board to receive the drawing as succeeding parts are finished.—SAMUEL DUKLER.

AIDS TO WARTIME Housekeeping

PAPER BLANKETS made of multilayers of cross-reinforced crepe paper have been developed to take the place of cotton and lightweight wool types. Laboratory tests have indicated that these blankets compare favorably in warmth-retention qualities to many kinds of textile covers. They are very light in weight and are snowy white in color with beige cotton-sateen bindings. Noninflammable and moth resistant, they come in the standard size 68" by 80". They are extremely low in cost, and can be used in the summer as a single covering and during the winter as an extra one

PLASTIC DRAIN STOPPERS to substitute for rubber ones are now on the market. They contain no metal or other critical materials and are available in seven standard sizes from 1" to 1¾" in diameter. Noncorroding, long lasting, and sanitary, these stoppers are said to have the same amount of elasticity and strength as the older types made of rubber. Even the rings on the stoppers are of plastic instead of metal





THE TRANSPARENT LUNCH BOX shown above is especially convenient for the war worker who has to submit his lunch equipment for a daily inspection. The box is made of a clear, sparkling, plastic material and opens from one end. It is designed to hold a 1-pt. vacuum bottle, sandwiches, and fruit, and it is easily kept in a clean, sanitary condition. The only metal used is in the rings holding the thermos

A CLEANING KIT containing materials for use on stainless steel, plastic, and enamelware utensils is shown in the photo at the right. The fluid cleaner contains no caustic abrasives, free alkali, or other injurious substances, and will not discolor, mar, or crock any utensils on which it is used. Besides the 12-oz. bottle of cleaning liquid, the kit contains two cellulose sponges, as well as a handy scouring pad. The cleaner is applied with one of the sponge pads, which is first dampened, and the utensil is then rubbed until all stains and marks are removed

PLASTIC JAR RINGS may be the much-needed substitute for rubber types, which are now proving hard to obtain. Tests conducted by the Department of Agriculture and by several food packers reveal that these new closures do as good a sealing job as the rubber rings. The necessary raw materials from which to make the rings are available, at least at the present time, in unlimited quantities, which is an added advantage. The rings are used in exactly the same manner as are the rubber ones, and come in widths and sizes to fit almost all jars and containers. They can be used by housewives and also by commercial packers

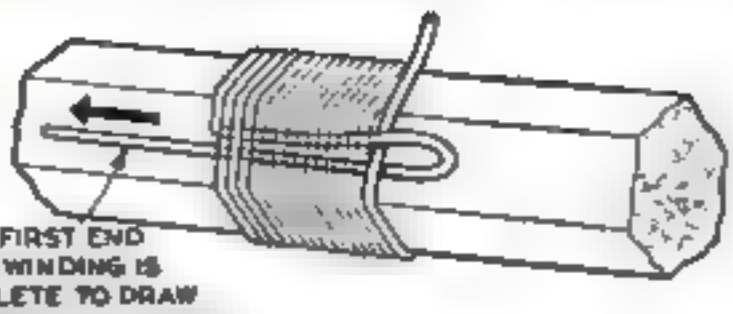
BEAM LANTERN. Easily focused, this lantern throws a half-mile beam and uses only a 6-volt battery. An unusual feature is a droplight on an extension cord, powered by the same battery, that can be used to illuminate near-by objects when the strong light of the beam is not needed

FLUTED PIE PLATES of heat-resistant glass are especially designed to prevent berry pies from losing their juices while baking. Pies are also automatically fluted when placed in these dishes, saving the housewife that tedious task. The plates are attractive enough to be used on the table. They may also be adapted for serving foods such as shortcakes, biscuits, and the like

WOOD AND FIBER CURTAIN RODS will save vital war materials, and are just as efficient as the metal types. The rods are finished in washable, baked-on, ivory enamel and are designed for windows up to 72" in width. They fit into brackets constructed of unfinished oak that can be painted to match surrounding trim or left natural and waxed. There are no sharp points or rough edges to snag the curtains. Should a very short rod be desired, simply get out the scissors and snip — the fiber is easily cut through, making the rods adjustable to almost any size window. Each package has full instructions for installing the rods

Amusing Stork Favor Is Made of Nuts and Pipe Cleaners

THIS amusing old bird is sure to make a hit at a stork party. A black walnut is used for the body. The tail, wings, and neck are made of pipe cleaners and attached with glue. Cut the tip and end from an almond meat and split the middle in half to form the head. Clamp a spring-type clothespin over the nut meat to hold it in place on the neck while the glue is drying. The beak is a reed or a toothpick, as are the legs and feet. Mount the bird on a square of cardboard or wood, shellac the head, paint in the eyes, and glue the "package" to his beak.



Colorful Fish-Rod Winding

ATTRACTIVE windings on fishing rods, tennis rackets, and similar objects may be made with variegated crochet thread. The thread is wrapped in a single even layer, with the ends looped under, as shown in the drawing above, to conceal them. When winding is completed, apply lacquer, varnish, or some other sealer. For small objects such as fishing rods, No. 70 tatting cotton is good.—W. E. B.

Saving the Special Alloy Used to Solder Aluminum Work

ALUMINUM solder can be saved if, after the surface to be soldered is tinned with the special alloy, ordinary solder such as the rosin-core type is used over it for the rest of the work. The two solders will mix and a patch of different metal, such as tin, zinc, brass, copper, or the like can then be applied. The result is a patch as strong as one made entirely with aluminum solder.—R. S.

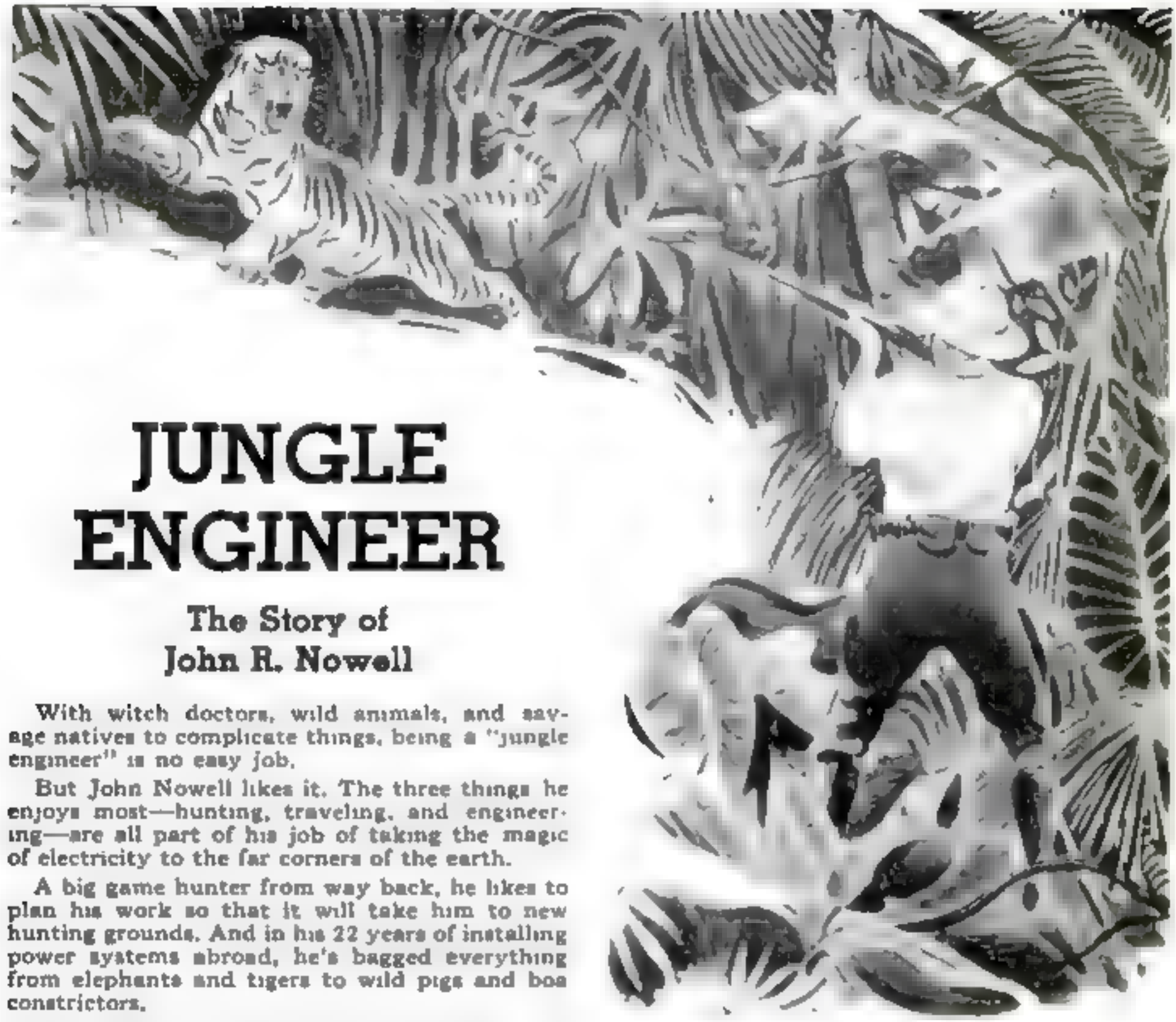
THE SQUARE KNOT

[KNOT WORK]

THE square knot, or reef knot as it is sometimes called, is one of the most important of all knots. It is used in first-aid work, in tying rope lengths together, and in all places where a strong knot, yet one that unties easily, is necessary. You can tie a square knot quickly and correctly every time by the following method

Place the rope end held in the left hand *over* the other end, holding both where they cross with the left hand. With the right hand reach under and grasp end *B* as shown in Fig. 1. Pull rope *B* under and then up as shown in Fig. 2. Now guide rope *B* first over and then under end *A*, as shown in Fig. 3. Holding end *B* in the left hand and end *A* in the right hand, pull taut, completing the knot, as in Fig. 4.

POPULAR SCIENCE MONTHLY SHOP DATA



JUNGLE ENGINEER

The Story of John R. Nowell

With witch doctors, wild animals, and savage natives to complicate things, being a "jungle engineer" is no easy job.

But John Nowell likes it. The three things he enjoys most—hunting, traveling, and engineering—are all part of his job of taking the magic of electricity to the far corners of the earth.

A big game hunter from way back, he likes to plan his work so that it will take him to new hunting grounds. And in his 22 years of installing power systems abroad, he's bagged everything from elephants and tigers to wild pigs and boa constrictors.

Of course he travels nowhere without his prized collection of guns, and this often leads to trouble. Japanese customs officials have even accused him of trying to start a revolution.

Nowell never traveled much until he became an engineer in the G-E Contract Service Department. Then his work took him to Russia, Africa, India, Japan, and South America.

Now a real globe-trotter, he even spends his vacation touring. Once he covered an open car with a heavy wire screen and drove 6000 miles through African grasslands where there was no road. The grass was taller than the car, and navigation was purely by compass.

Nowell has a knack of picking up different languages as he travels. As a result he speaks four languages and a number of dialects.

And sometimes it's handy to have the right word on the tip of your tongue. For example, one day Yuma, his cook, announced that he had been cursed by a witch doctor. So Nowell mumbled a few well-chosen words, brewed a bright red potion and erased the curse.

There's nothing dull about jungle engineering. On one job, Nowell discovered that all his dowel pins (used for securing machinery to its base) had disappeared, and he had to make a new set by hand. Months later the original pins turned up—in the noses of a half-savage tribe of the Belgian Congo!

Another time, natives stole the very packing cases off a generator, exposing delicate parts to damage in transit. But Nowell rigged up a machine and trued the parts within 15 thousandths of an inch of perfection.

Although he misses the adventure of jungle engineering and itches to be on the move again, Nowell thinks his job is in America now, and he's working on a plant that will generate the power for several war industries in the West.

It takes men like John Nowell—fearless, selfless, plucky men—to win a war. And it takes the same kind of men to make this world a better place in which to live once the war is over. *General Electric Co., Schenectady, N. Y.*

GENERAL ELECTRIC

How We Can Smash Japan

(Continued from page 56)

Diomede and Big Diomede Islands, Alaskan and Siberian territory respectively, face each other within easy viewing distance of only a mile.

Farther south, the long chain of Alaska's Aleutian Islands extends to within 750 miles of Japanese territory. Here lies Paramushiri, at the outer end of the Kuriles, which form an extension of the four principal Japanese islands—Hokkaido, Honshu, Shikoku, and Kyushu—in lower latitudes.

This little study in geography has not escaped Oriental notice. Last June, a few bombers bearing the Rising Sun emblem paid brief calls on our advanced air base of Dutch Harbor, in the Aleutians—perhaps as much to look us over as to set afire several fuel tanks. Next, small seaborne Jap forces moved in on some of the outermost, inhospitable islands of the Aleutian chain—Attu, Agattu, and Kiska. They brought seaplanes with them. U. S. Army Air Forces promptly countered by setting up a base in the Andreanof Islands, several hundred miles beyond Dutch Harbor. This brought both American bombers and short-range fighter escorts within striking distance of the hapless Japs, for whom an occasional lifting of the bleak region's fogs meant only a pelting with high explosives. Now and then, U. S. men-of-war varied the monotony with artillery fire.

What they were up to remains anyone's guess. Propaganda for home consumption? Weather observations? Attempts to establish submarine bases? Patrol posts to watch U. S. movements? Or, conceivably, advance reconnaissance for a force to invade North America?

If the last, it may be observed that an invasion route sometimes works both ways. Our own end in Alaska, where 300 infantrymen long guarded a territory bigger than Germany and France combined, has been made secure. A central air base at Fairbanks and numerous coastal bases are backed up with reinforcements and supplies from the United States by sea, by air, and now by the recently completed Alcan Highway, an invulnerable inland route. In turn, here are the means of striking a mortal blow at the heart of Nippon.

Subscribers in the armed services who notify us of change of address are requested to give us the key symbols appearing on the wrapper in which the magazine is received.

IN A TAPERED ROLLER BEARING

Count the Rolls— ...the Rolls count!

★ When you want long, dependable service in a tapered roller bearing, don't overlook the importance of the *rolls*.

It's the *rolls* that *carry the load*. Other things equal, the bearing with more rolls carries more load—lasts longer—gives better performance.

That's why there's a growing preference for Tyson Cageless Bearings for heavy-duty service in industry and essential transportation. Size for size, Tyson Bearings have more rolls—the raceway is *completely filled* with load-carrying rolls. They have longer life, more capacity, maximum rigidity.

You'll go farther with Tyson.

TYSON BEARING CORPORATION
MASSILLON, OHIO

Tyson HEAVY-DUTY BEARINGS

Tyson products also include precision parts for America's airplane engines

Our Aircraft Engines

(Continued from page 115)

air into the cylinder. Combustion occurs only in the presence of oxygen, and this vital gas becomes scarce at high altitudes because the oxygen molecules are widely scattered. At sea level, the molecules are compacted by the mass weight of all the air above. It is the supercharger's function to suck in as many oxygen molecules as possible, cram them into the carburetor, and deliver this compressed air-and-fuel charge to the cylinders.

The most widely used type is the centrifugal supercharger which consists principally of a many-bladed fan or blower, called the impeller, that is driven at high speed by a train of gears linked with the engine crankshaft. Centered within a housing at the rear of the engine, the impeller whips the atomized fuel against a unit resembling a pinwheel, known as the diffuser. Unlike a pinwheel, however, the diffuser doesn't turn; its function is to slow down the terrific velocity of the vapor as it comes off the impeller-blade tips, changing the speed to pressure. The supercharger does something besides boost the mixture intake: the whirling blades of the impeller agitate the fuel and air into such turbulence that a much higher degree of vaporization is gained—the oxygen molecules are more evenly mixed with the particles of gasoline and more complete combustion results. Furthermore, this turbulence hastens the transfer of heat after the power stroke. This variety of supercharger, having one impeller that turns at constant speed, say, seven times the crankshaft r.p.m., is called a "single-stage, single-speed" supercharger.

When the impeller is geared in low and high ratios, the super is called a "single-stage, two-speed" type. After the manner of the low and high gears in an auto, the former is used for the take-off and ascent to intermediate levels and then stepped up to high ratio for the long climb to higher altitudes. The change-over is made through a mechanical clutch which is operated by the pilot, or may be made gradually with a semiautomatic hydraulic clutch that operates on the fluid-drive principle.

In the higher horsepower brackets, we find the "two-stage" supercharger, having two impellers connected in a series. The first stage of compression is routed on to the second blower for additional boosting before being fed to the cylinders. This impeller may be cut in manually by a mechanical clutch, or automatically by means of a

(Continued on page 206)

THIS IS A NUT . . . but

It looks much like any other nut, except for a "locking ring" of elastic material inserted in its top.

It fits any standard bolt.

It goes on like any other nut, except that it is wrenched on instead of being spun on with the fingers.

But it is unlike any nut you have known in the past because:

When it goes on it stays on.

In spite of vibration, stress, strain, this Elastic Stop Nut will not loosen, slip or break.

It may be removed as needed—and still locks itself tight when put back.

It *licks* vibration.

And not a single one has ever failed in service, to our knowledge, though our total production now adds up to billions.

ELASTIC STOP NUTS

Lock fast to make things last

ESNA

ELASTIC STOP NUT CORPORATION OF AMERICA
UNION, NEW JERSEY

Our Aircraft Engines

(Continued from page 204)

hydraulic clutch. Intercooling, a radiator system for lowering the temperature of the highly compressed mixture as it passes from one stage to the other, is sometimes used between the two impellers to prevent preignition or detonation in the cylinder

The ultimate in superchargers is the turbo-blower. This type is used in combination with a built-in single-stage "super" and usually is installed on the outside of the engine cowling. The motor's exhaust is discharged at pressures considerably higher than those of the atmosphere, and the turbo utilizes these gases which would otherwise be wasted. Furthermore, it makes use of this power without robbing the engine: the centrifugal types eat up as much as 200 horsepower—enough to fly another good-sized airplane. The exhaust is routed through a small turbine that turns an impeller mounted on the same shaft, and this boost is passed on to the engine intake.

Installations in our most famous warplanes include all these methods of supercharging. The Bell Airacobra models which have been in service for some time are powered by an Allison liquid-cooled engine that uses a single-stage, single-speed supercharger. The Lockheed Lightning's two Allisons have their single-stage supers complemented by General Electric turbo-superchargers (P S M., June '41, p. 66). The high-flying Boeing Flying Fortress is powered by Wright Cyclones that use both single-stage and turbo-supercharging. The Republic Thunderbolt has a turbo-super connected with its Pratt & Whitney Double Wasp engine. The Vought-Sikorsky Corsair uses a Double Wasp with two-stage two-speed supercharging. Three-stage superchargers—a built-in, two-stage blower supplemented by a turbo—are now in the works.

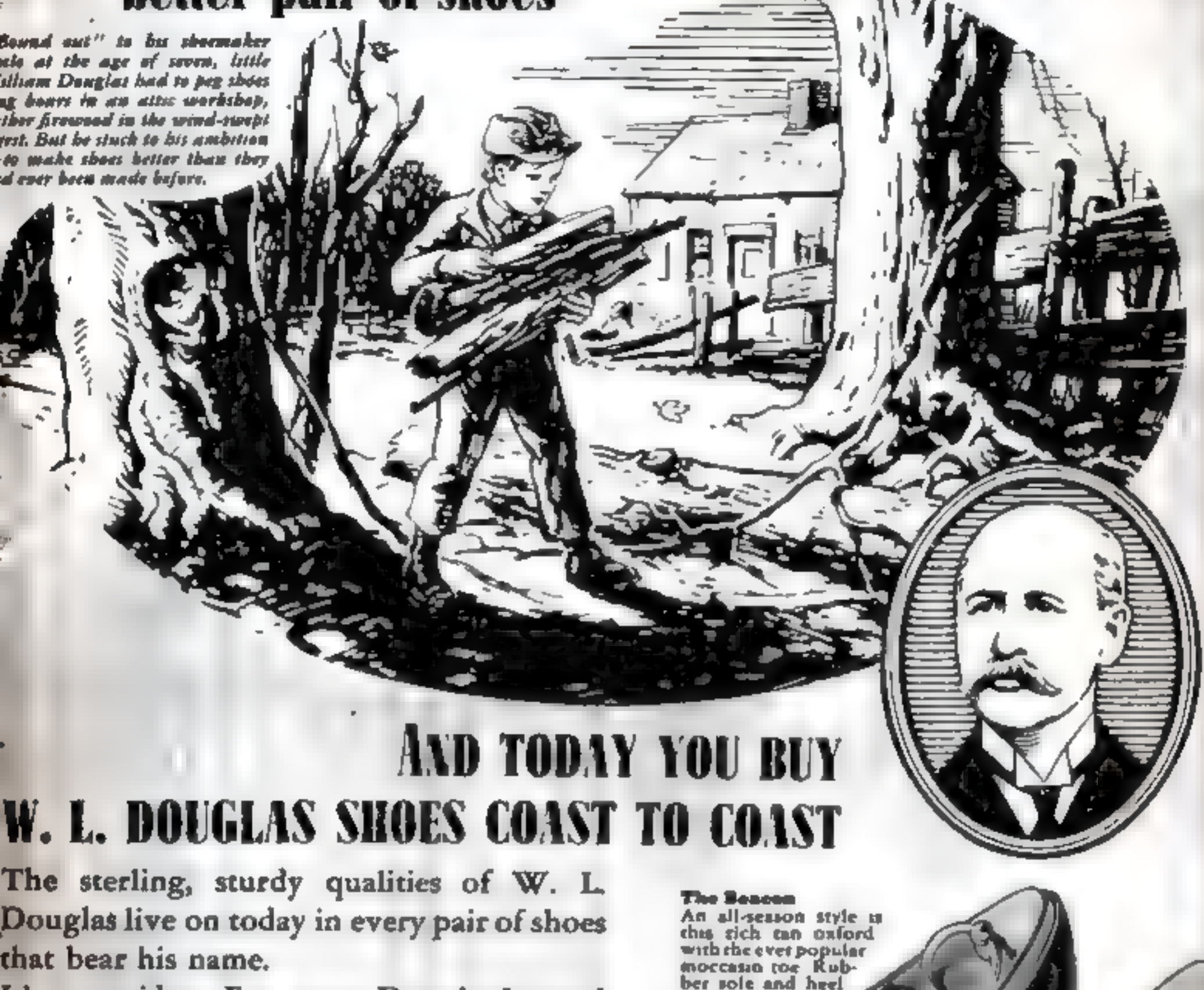
Retaining the engine's sea-level power at high altitudes is only part of the conquest of the stratosphere. Controllable propellers whose blades may be changed in their pitch, automatically or manually, are essential because of the need for the propellers to get a bigger bite on the rarefied air of the upper levels. For take-off and initial climb, the blades are set in low pitch, so that they appear flat and thin when viewed from the side. In this position, the blades have little braking effect on the engine, permitting it to revv up to full power for maximum pull. In high pitch, the blades meet the air at a greater angle and thus maintain thrust in thinner air; they also prevent the engine

(Continued on page 208)

He wanted to build a better pair of shoes

Listen to John Stanley on Mutual Network — Sunday 10:30 P. M.

Bound out" to his shoemaker uncle at the age of seven, little William Douglas had to peg shoes long hours in an attic workshop, while firewood in the wind-swept forest. But he stuck to his ambition to make shoes better than they had ever been made before.



AND TODAY YOU BUY W. L. DOUGLAS SHOES COAST TO COAST

The sterling, sturdy qualities of W. L. Douglas live on today in every pair of shoes that bear his name.

It's no accident. For young Douglas learned the shoemaker's trade the thorough, *right* way.

That's what makes the difference in the W. L. Douglas Shoes you buy today. It's not just extra fit, — extra good looks. You get those, naturally. But you get something deeper, more personal. For there's the master touch of young Douglas — a lifetime of "knowing how". Try them today!

The Beacon
An all-season style in this rich tan oxford with the ever popular moccasin toe. Rubber sole and heel No. 4955.

Other styles at $5.

The Cromwell
Straight-tipped oxford with the famous Douglas Arch construction. Tan calf uppers take a brilliant shine No. 4528

$6.50 to $8.50

Douglas "Down-to-the-Wood" construction assures you better fit.

W. L. Douglas Shoes

W. L. DOUGLAS SHOE CO., BROCKTON, MASS.

Stores in Principal Cities

Good Dealers Everywhere

Our Aircraft Engines

(Continued from page 206)

from racing and losing efficiency. In hydromatic or electrically controlled propellers, the blade angle is changed automatically during the climb to permit the engine to operate at its best r.p.m. reading.

The amount of boost being furnished to the intake by the supercharger is indicated to the pilot on a manifold-pressure gauge that is calibrated in "inches of mercury," and he tells how fast the engine is turning over by watching the indicated r.p.m. on the tachometer. Different engines, and different models of the same engine, are rated according to their optimum output under certain combinations of manifold pressure and r.p.m., regardless of whether they are sea-level engines or altitude engines. For example, a boost of 35 inches and a reading of 1,900 r.p.m. is maintained as the plane climbs by opening the throttle gradually. When the altitude is reached where you can maintain these readings only at full throttle, you have reached the "critical altitude" of the engine—the level at which it develops its maximum power output. This is not to be confused with the critical altitude or service ceiling of the plane itself, which is many thousands of feet higher. Engineers are striving toward the goal of getting the critical altitudes of engine and plane as close together as possible.

Another objective is to decrease the horsepower-weight ratio of their engines, and remarkable advances have been made in this direction. This is one of the points of marked superiority of American engines over those of the European nations. The first Wright engine weighed 12 pounds per horsepower. Until about three years ago, the one-pound/horsepower ratio was considered the ideal, but now we have surpassed even this standard.

But lower horsepower-weight ratios will be achieved in comparatively small measure by making the engines themselves lighter. The problem is being attacked from another angle, that of increasing the horsepower by a greater percentage than the engine's weight. The new engines are considerably heavier, but they are so much more powerful that the horsepower-weight ratio is lower.

The efficiency of our power plants depends upon packing more horsepower into a package which is relatively the same weight and size. This is being accomplished by the use of forged cylinder heads, better cooling methods, more efficient supercharging, and

(Continued on page 210)

Our Aircraft Engines

(Continued from page 208)

use of new and lighter materials. The Wright people lighten a Cyclone by making 180 pounds of magnesium do the work of 270 pounds of processed aluminum. Push-rod housings and cylinder baffles are now being made of plastic instead of metal. The new higher-octane fuels are doing as much to reduce the weight-horsepower ratio as any other single factor, because they provide more power at full throttle (both at take-off and at critical altitude) increase the engine's critical altitude, and bring about lower fuel consumption.

Superb as our engines now are, even finer ones are going into service in the near future. They are designed for mass production and easy field maintenance. However efficient an engine may be, it is not a good military power plant if it cannot be produced in sufficient quantity to get the required number of planes using this engine into tactical service. Nor is it good if it is so complicated in design that mechanics—who may have to work in the desert or in the Arctic, and with only limited equipment—cannot keep it in service. This is another department in which U. S. engines excel; they run well, do not require too frequent overhaul, and are easy to service.

Rather than new ideas, it seems likely that we shall see, in late war engines and the engines which will power our peaceful wings, new applications of older basic principles. Fuel-injection power plants, reaction-type engines, and perhaps jet propulsion may come into wider use, but it is doubtful if any of these will replace our present war engines. The conventional types are too good, and we shall have a lot of them.

Water-Repellent Solutions for Dry Cleaner, Laundry

IMPROVED water repellents developed by Du Pont can be used by dry cleaners and laundries in connection with their fluids and wet washes. Clothes are dipped in a solution after dry-cleaning or laundering. The chemical treatment of the fabric cannot be seen or felt, has no odor, and does not impair the appearance or draping qualities of the garment. Cotton dresses and men's summer suits treated in this manner are said to be protected against moisture and perspiration so that they will not soon lose their shape or crease. It is said that a fabric made water-repellent by these chemicals does not prevent normal body evaporation.

. . . but here is one worry you can avoid

THIS war has changed fashions in *driving* as well as fashions in clothes. Today, you use your car less . . . make shorter, more infrequent trips.

This means that water and sludge can accumulate in the crankcase . . . pistons and bearings may be exposed to rust; scale and rust can ruin your radiator; tires and battery may deteriorate and wear out faster.

That's why, today, there is more reason than ever before to protect *your* car with Marfak 40-point Chassis Lubrication Service. This thorough, stem-to-stern service leaves nothing to guesswork. It guards vital, irreplaceable parts, helps keep your car working in tip-top shape.

Remember, Uncle Sam *needs* your car on the job. So instead of *worrying* about possible breakdowns, guard against them by insisting on genuine Marfak Lubrication Service. At Texaco and other good dealers everywhere.

TUNE IN: FRED ALLEN every Sunday night
See your local newspaper for time and station.

You're Welcome at **TEXACO DEALERS**

The Bulldozer Grows Wings

(Continued from page 70)

way about a mile long, of level, hard-packed earth, steel mats, or asphalt to make an effective landing strip for our Flying Fortresses. One somewhat smaller will serve our fighter planes. On one of these jobs, the airborne engineers had some help from Arab labor, paid in American cigarettes.

These two fields were a source of grief to the Nazi forces in Tunisia, and to convoys coming up to supply them. Then came Rommel's short-lived attack, which overran one field temporarily. When American troops recaptured the field, they got a chuckle. Our Aviation Engineers had been forced to withdraw too fast to destroy all their heavy equipment, but had camouflaged it so well that the Nazi forces failed to find it.

As now organized, each Airborne Aviation Engineer battalion consists of a headquarters company and three construction companies, with a strength of about 600 men and officers. A lieutenant colonel commands each battalion, and with him are seven staff officers.

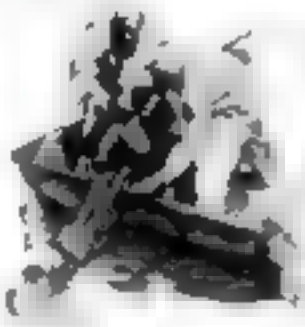
Each construction company has seven tractors, three scrapers, two graders, a roller, five jeeps, two trucks, and so much other miscellaneous equipment that it takes between 15 and 20 of the big C-47 planes to transport it. All the equipment is adaptable for use in gliders. Inasmuch as the engineers must fight as well as work, they are loaded with fire power: rifles, tommy guns, pistols, carbines, and .50 caliber machine guns with which to fight off dive-bombing and machine-gunning attacks from the air. It takes five months to train one of these companies; aside from their technical training, emphasis is placed on physical toughening.

Obviously, the light equipment carried by the airborne aviation engineers is not suited to carry the main load of building the Army's airfields. The standard-size, heavy equipment being used by our aviation engineer battalions around the world will always do the bulk of the work. But the airborne unit is now of proved value as a weapon of opportunity, adding flexibility and speed to our forces in some situations. It bears about the same relation to the heavy equipment as does a light, quickly thrown ponton bridge to the heavy, fixed bridge which is to replace the ponton bridge later.

The airborne units will not be charged with building or repairing elaborate ground installations, or attempting elaborate cam-

(Continued on page 214)

EVINRUDE POWER for Swift Storm Boats



"Storm Boats" they're called . . these slashing little hurricanes of power and speed. They can float in mere inches of water. They can weave, twist, dart like furious hornets. And they can whisk a landing force to a beach in a breath-taking hurry!

Motors for the Storm Boats . . motors jam-packed with power and stamina . . . the assignment to build them was given to Evinrude. Years of experience building great racing Evinrudes, mightiest of outboards, gave quick answer to every requirement of speed and ruggedness and "fighting heart". Down the production lines they came . . . dynamic "storms" of eager power to drive the fleets of Storm Boats!

Giving top speed to assault craft . . . driving heavily laden barges and lighters . . . capably powering small boats of every type . . . Evinrude motors are serving on many fronts! Building for Victory is our sole job now . . . with peace, there will be brilliant new Evinrudes for happy days on the water again.

EVINRUDE MOTORS, Milwaukee, Wisconsin
Evinrude Motors of Canada, Peterboro, Canada

The Bulldozer Grows Wings

(Continued from page 212)

ouflage work, though they are schooled in rudimentary camouflage for self-protection. Their job is to provide quickly the minimum landing facilities necessary to allow planes to operate.

In the case of captured fields, they may fill bomb craters; neutralize contaminated areas; help combat engineers remove booby traps, mine fields, and other obstacles; construct dispersal areas, and repair access roads and all kinds of utilities. The portable steel landing mats which are now being shipped by the millions of square feet to our airfields all over the world are too bulky for much use by these airborne aviation engineers, except in small quantities for patching and special jobs.

Essentially, these new troops are pioneers, adding to the speed of air war, the speediest war there is. Their ranks are open for tough, skilled men who are looking for plenty of action.

Underwater Sound Waves Cause Abdominal Injury

UNDERWATER sound waves resulting from exploding depth charges or other subsurface explosions are causing a peculiar abdominal injury to seamen that has Navy doctors shaking their heads. The waves are invisible and do not compress the water. But they travel at a speed of four fifths of a mile a second, and are likely to result eventually in the death of anyone in the water within 150 feet of the explosion. What occurs is that the sound waves damage masses of tiny blood vessels in the abdomens of men swimming in the water. This causes a reduction in the blood supply to the viscera and a consequent visceral starvation, which in turn causes small ulcers. It is the perforations resulting from these ulcers that cause death.

Sheets Advocated for Soldiers When They Sleep in Open

TESTS conducted by the National Bureau of Standards show that bed sheets for the American soldier sleeping in the open would do more than bring him merely one of the refinements of home life. They would also be the most effective means of keeping him warm. Experiments have shown conclusively that the combination of a light woolen blanket and two cotton sheets gives much greater warmth than a single heavy blanket.

Translated from the German

A CAPTURED German dispatch, during the last war, is revealing—and just as true today. We quote [illegible]

If you expect to join our armed forces, start learning as much as you can about rifle shooting NOW! For knowing how to handle a rifle can help you *get ahead faster* in the Services, and—it may save your life. Read this letter, typical of many

"Last year we had 45 students in our (rifle) club, and many have gone into military service. Practically every one has benefitted from his training with us by qualifying as an Expert Rifleman, and has consequently received an increase in pay and promotion as well." Director of Athletics, Ohio.

But—less than 2% of inducted men know anything about rifle arms! That is why O. F. Mossberg & Sons, Inc., urges *every* owner of a .22 rifle to help teach a neighbor how to use a gun.

Share your rifle with your neighbor

—under nationwide Training Program sponsored by National Rifle Association, Washington, D.C.

This program is intended to train the maximum number of our citizens in the use of small arms. It is invaluable to civilian defense units, guards, etc., and to *all* prospective service men. For in *this* war, even quartermasters, signal corps and cooks are armed—and must learn how to shoot. And the basic principles of aiming and trigger release are the same for riflemen, artillerymen, pursuit pilots and bombardiers.

So . . . share your rifle wih your neighbor, under the NRA training program. Ammunition is made available by interested government departments through the National Rifle Association. *Join or start,* a local rifle club—*now!*

Help make America a nation of marksmen—*unconquerable!* Mail the coupon for helpful, free booklets—today.

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3976 St. John St., New Haven, Conn.

Please send "The Guidebook to Rifle Marksmanship", also *new* Questions-and-Answers folder which tells How and What to Do NOW.

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City.......................... *State*..........................

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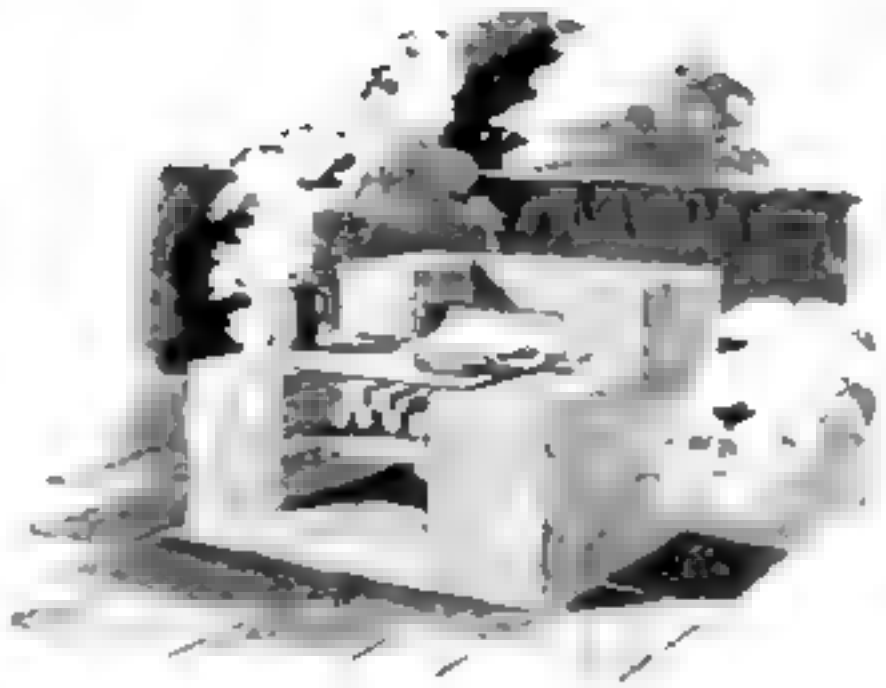

Furnishing Your Garden for Fun Out of Doors

IT'S NO hardship to stay at home if your garden or back yard is outfitted for fun. Comfortable outdoor furniture, plus a good fireplace, will set the scene for gay barbecue parties, lazy days of relaxation, or pleasant twilight companionship. Our 20-page booklet, *Garden Fireplaces, Furniture, and Pools* (35 cents), is chock-full of designs for accessories that will help make any garden more livable.

Do you like to build boats, models, or craftwork articles? Good blueprints are a tested help. A few are listed below; for a complete list, send a stamped, self-addressed envelope.

All-Purpose Boat, 11' 5" long, 331-R	$ .75
Combination Boat, 13' hull for use with sail outboard motor or oars, 131 132 133-R	1.00
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Fishing Schooner WE'RE HERE of "Captains Courageous." 9½" over all, 351-R	.50
Four-Leaf Card or Occasional Table, 230A	.25
Gate-Leg Table 3' 6" diameter, circular top with leaves up, no turning, 24	.25
Hostess Tray, Modern Book Ends, Machinist's Hammer, Lathe Dog, 412A	.25
Magazine Rack and Wooden Wastebasket to match, 296A	.25
Miniature Fleet of Nine Modern U. S. Fighting Ships (full-size plans and instructions in booklet form), 372-R	.50
Sectional Rowboat, 9' 6" long; can be used with small outboard, 340-341-R	.75
Utility Rowboat 13' long, can also be sailed or driven by outboard motor 224-R	.50

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PRODUCT OF P. LORILLARD COMPANY

FINISH THE JOB RIGHT

Like setting the last rivet as the plane comes off the production line—burring, finishing and polishing to minute specifications mean the job is right.

CHICAGO MOUNTED WHEELS

Famous since their introduction 45 years ago for quality and long life. There is a "just right" Chicago Mounted Wheel for every operation.

PROMPT DELIVERIES—We are working 24 hours a day and due to our central location, can make prompt shipment on all Mounted Points and Grinding Wheels 3" in diam. and under. With the approval and endorsement of WPB, all our facilities are concentrated on these smaller sizes, enabling us to give the most potent service to the war program.

HANDEE TOOL OF 1001 USES and HI-POWER GRINDERS have gone to war—available to all who have priorities.

FREE Catalog, shows actual sizes and colors of largest line of Mounted Wheels made

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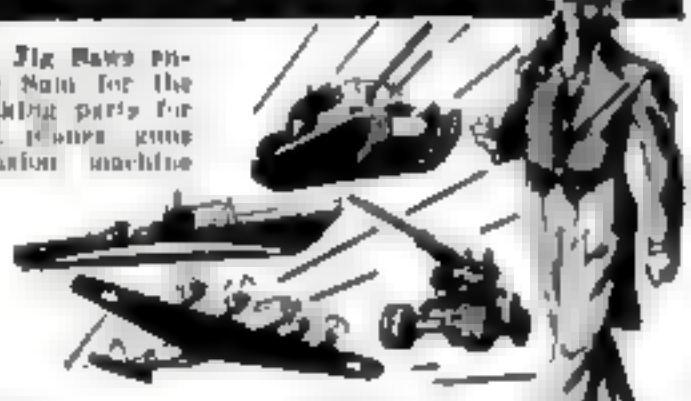
IN STEP WITH UNCLE SAM



SYNCRO Electric Jig Saws mated with Uncle Sam for the duration . . . making parts for tanks, submarines, planes guns — producing precision machine tools, fixtures, gauges, production parts. Laboratory research guaranteed BETTER Syncro Saws for you after Victory!

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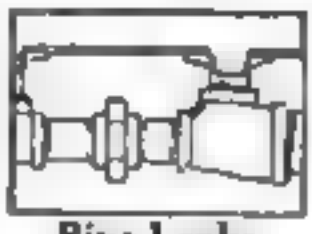
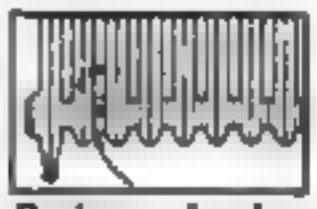


Pipe Leaks

Tank Leaks



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DIC-A-DOO PAINT BRUSH BATH

I'm keeping a nose on things

I'M JUST A HOUND DOG called Butch to about everybody but The Boss. To him I'm *The Nose.*

Why, he'd no more think of going hunting with any other nose than he'd think of going without his gun!

But now The Boss has gone to war.

"Keep a nose on things, Butch," he said when he left. And am I doing it! Just wait till I show him that new place I've found . . . when it's peacetime again.

HERE AT REMINGTON we are doing everything in our power to speed peace through victory . . .

—during 1942, Remington produced enough small arms ammunition to fire 300 times at every Axis soldier.

—during the last 7½ months of that year alone, Remington produced more small arms ammunition than the entire country produced during all four years of World War I.

—thousands upon thousands of military rifles were speeded to our armed forces all over the world.

—and Remington has received four Army-Navy "E's."

We of Remington are grateful that we are able to serve our country. And after the war is won, we will be glad to serve our sportsmen friends again with the famous Remington line of sporting arms and ammunition.

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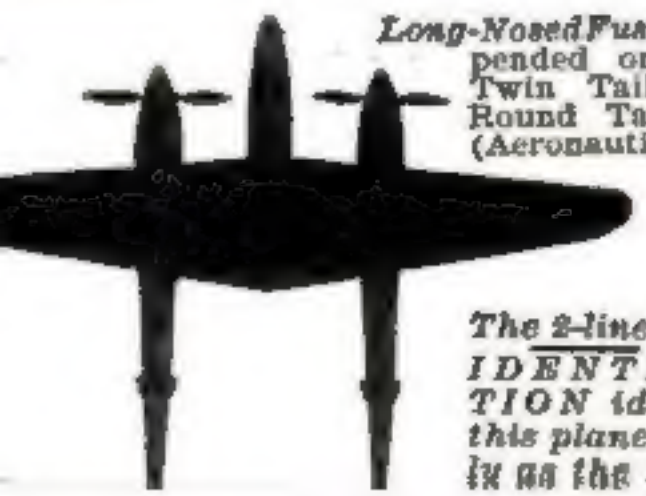

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